

30 Minute Antennas

Pacificon 2015

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About Me:

- 35 Years doing Antenna Work
- Pioneer in Internal Antenna Design
- 52 US Patents Granted
- 30 International Patents Granted
- 600 Million Products with my Antenna Designs Inside

Materials Needed

- Blank FR4: McMaster Carr
- Copper Tape: McMaster Carr
- Semi-Rigid 50 Ohm Coaxial Cable: Amawave
- Calculator: iPhone
- Exacto Knife: Hobby Lobby
- Ferrite Beads: Amadon
- Double-Backed Tape: McMaster Carr
- Foam Insulation: Owens Corning

Reference Designs

- IN-LINE DIPOLE
- PERPENDICULAR DIPOLE
- LOOP
- DOOP
- SLOT
- INVERTED F ANTENNA (IFA)
- YAGI
- PATCH

Radiation Pattern Shapes

- IN-LINE DIPOLE: Vertical Omnidirectional
- PERPENDICULAR DIPOLE: Horizontal Figure 8
- LOOP: Vertical Omnidirectional or Horizontal Figure 8
- DOOP: Horizontal Omnidirectional
- SLOT: Vertical Figure 8
- IFA: Vertical Omnidirectional
- YAGI: Linear Directional
- PATCH: Linear Directional

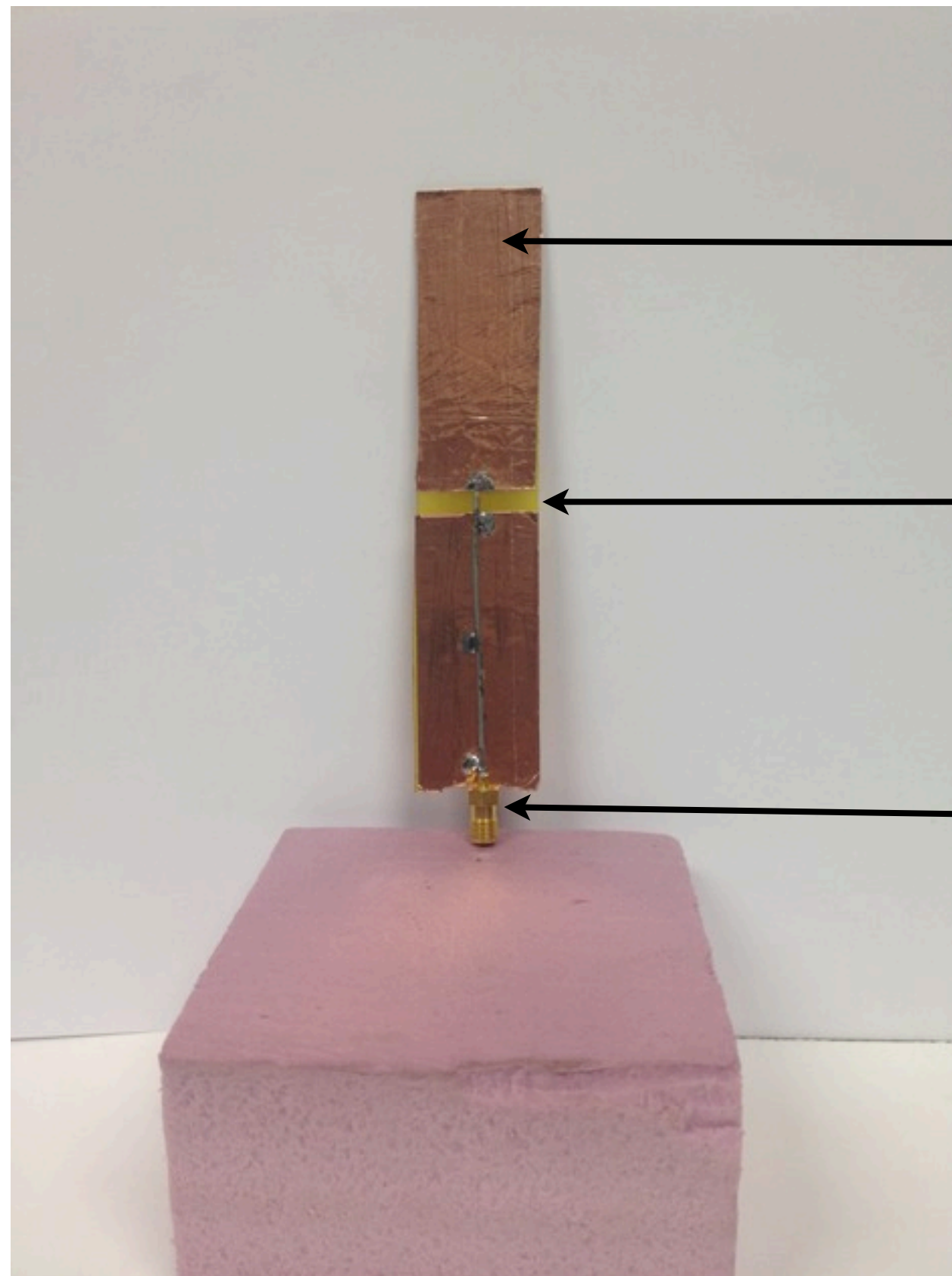
Formulas Needed

- Wavelength = $12000/\text{MHz}$ [Inches]
- Sample Wavelength Calculations:
 - 500 MHz: $WL = 12000/500 = 24$ inches
 - 300 MHz: $WL = 12000/300 = 40$ inches
 - 1000 MHz: $WL = 12000/1000 = 12$ inches
- NOTE: All Antennas Presented Here Are Designed for a Frequency of 1000 MHz
- Scale all dimensions presented as needed for a different frequency by using wavelength scale

Reference Designs

- IN-LINE DIPOLE: Halfwave Design
- PERPENDICULAR DIPOLE: Halfwave Design
- LOOP: Full Wavelength Design
- DOOP: Halfwave Design
- SLOT: Halfwave Design
- IFA: Quarterwave Design
- YAGI: Halfwave by Halfwave Design
- PATCH: Halfwave Design

In-Line DIPOLE

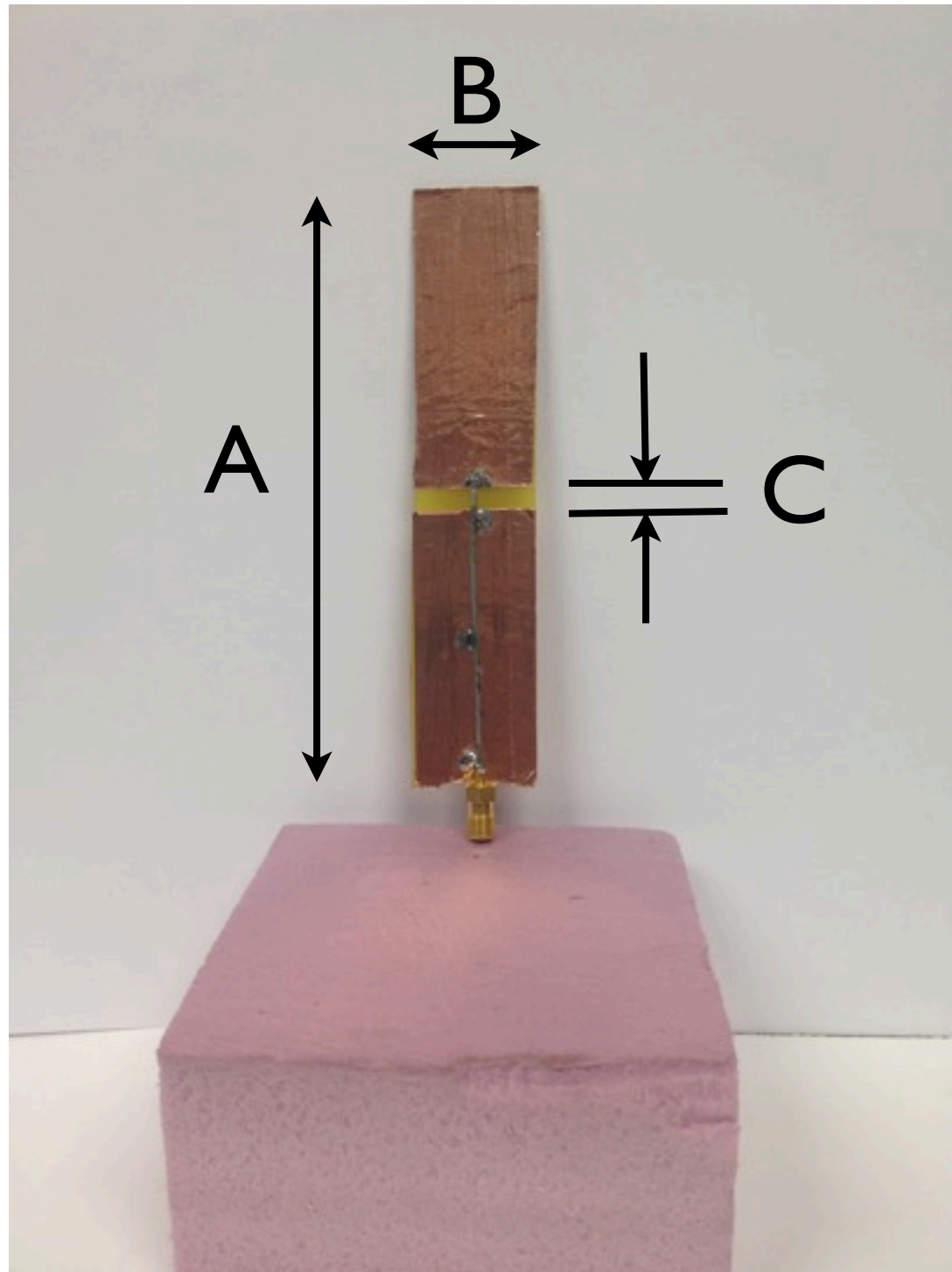


Copper
Tape

FR4

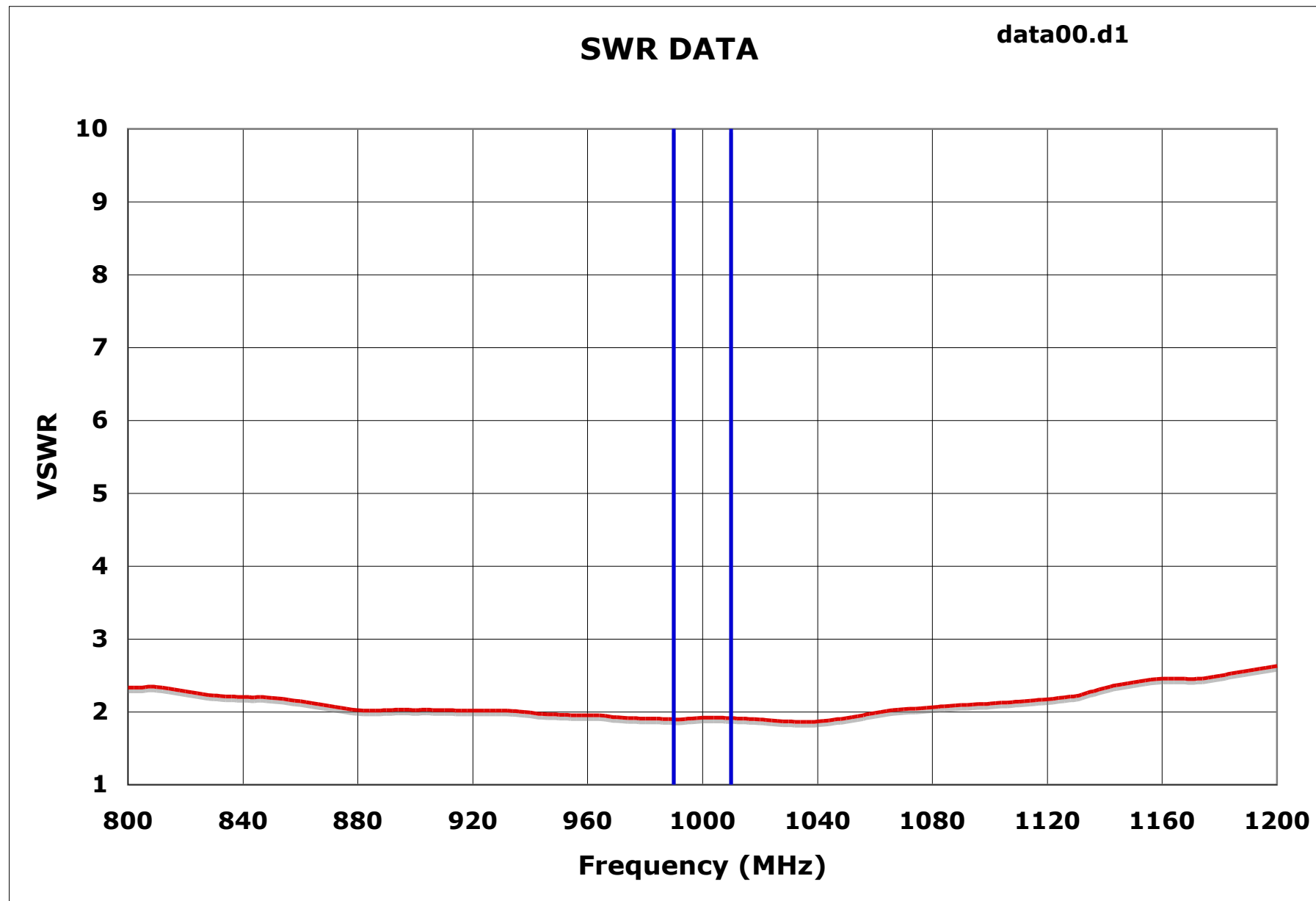
50 Ohm
semi-rigid
coax cable
with sma
connector

In-Line DIPOLE: Dimensions

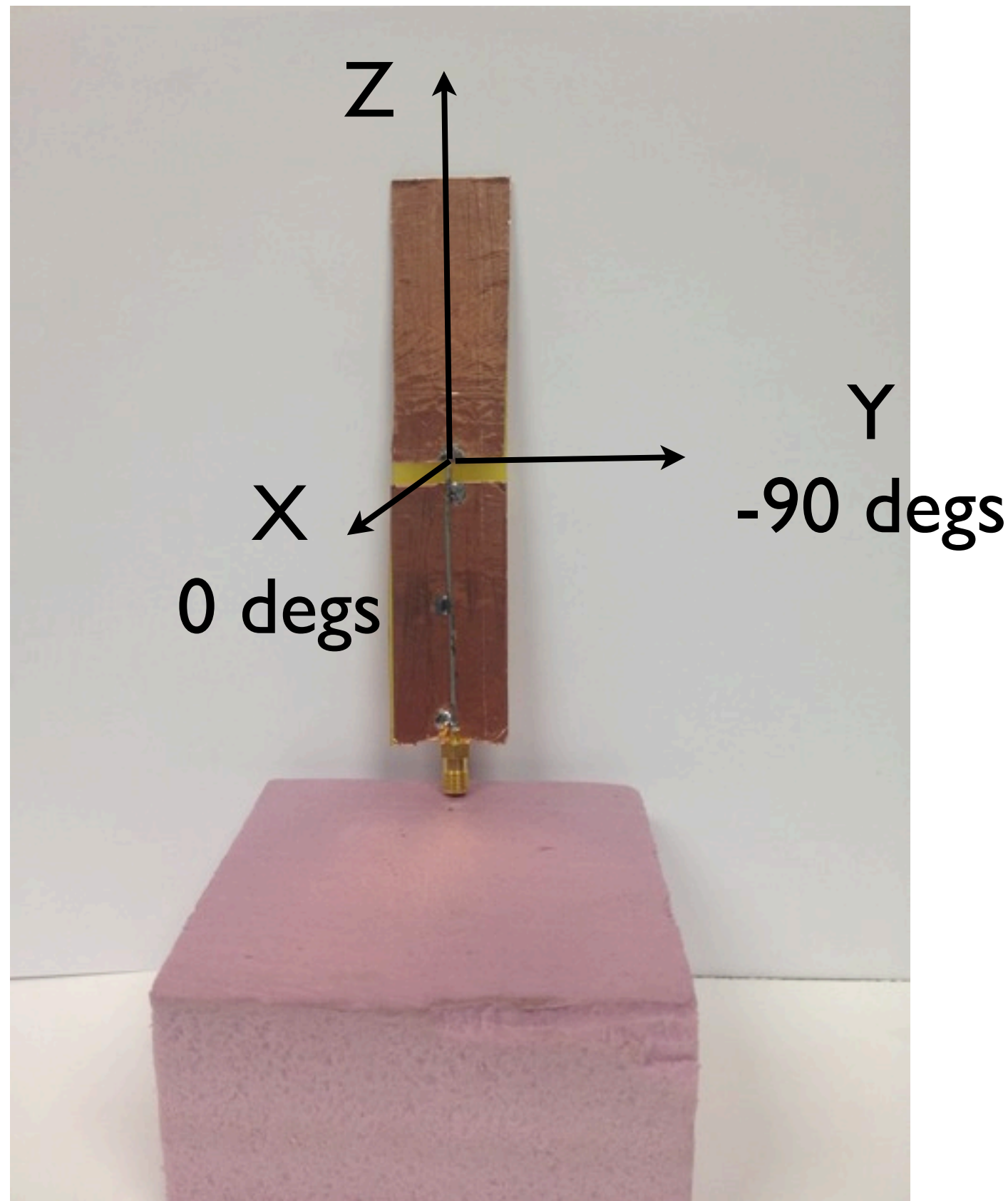


IN-Line Dipole		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	4.80	0.40
B	1.00	0.08
C	0.20	0.02

In-Line DIPOLE: VSWR



Pattern Orientation

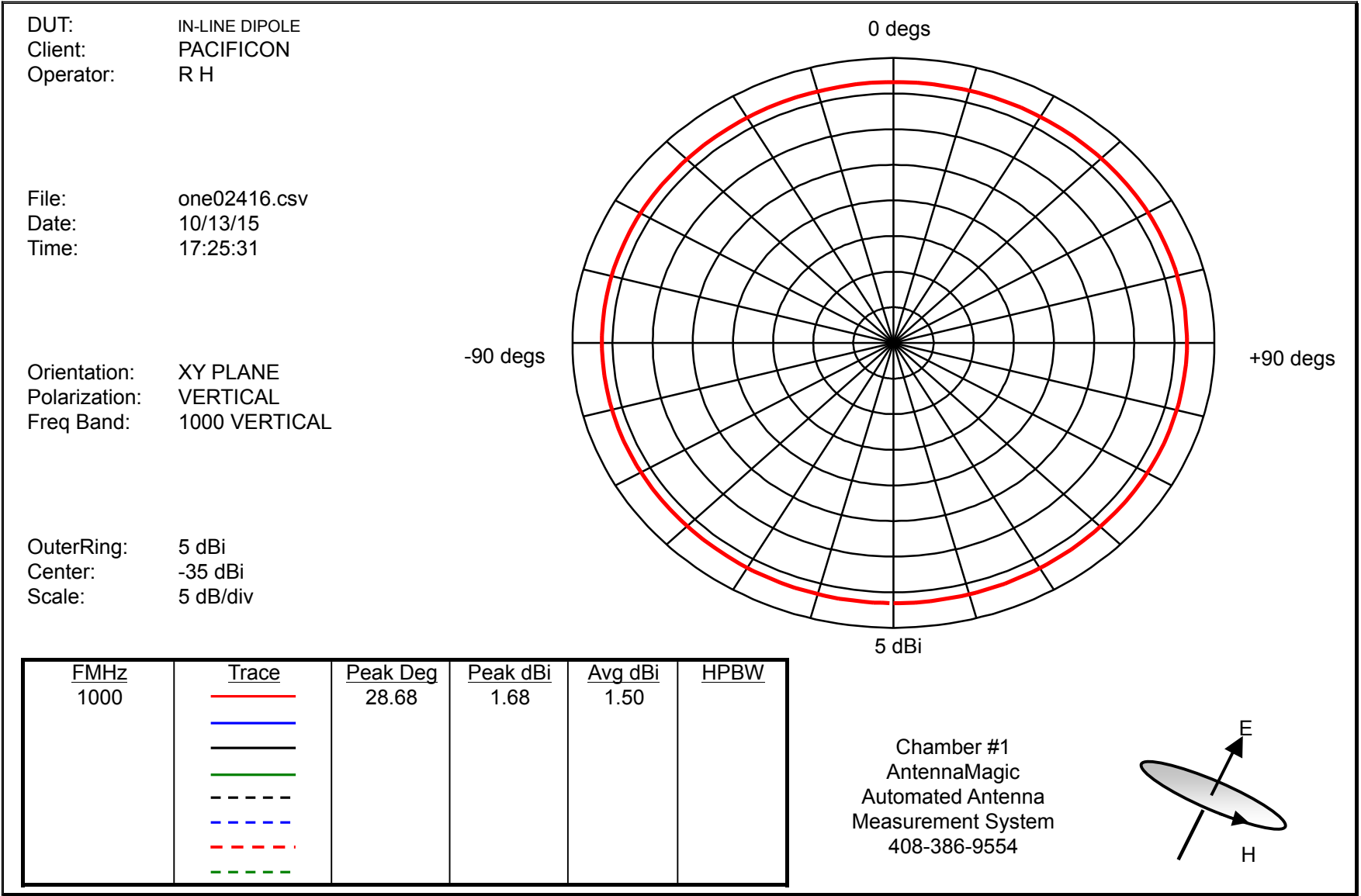


In-Line DIPOLE: Pattern

Antenna Radiation Pattern

MagicPlots.xls

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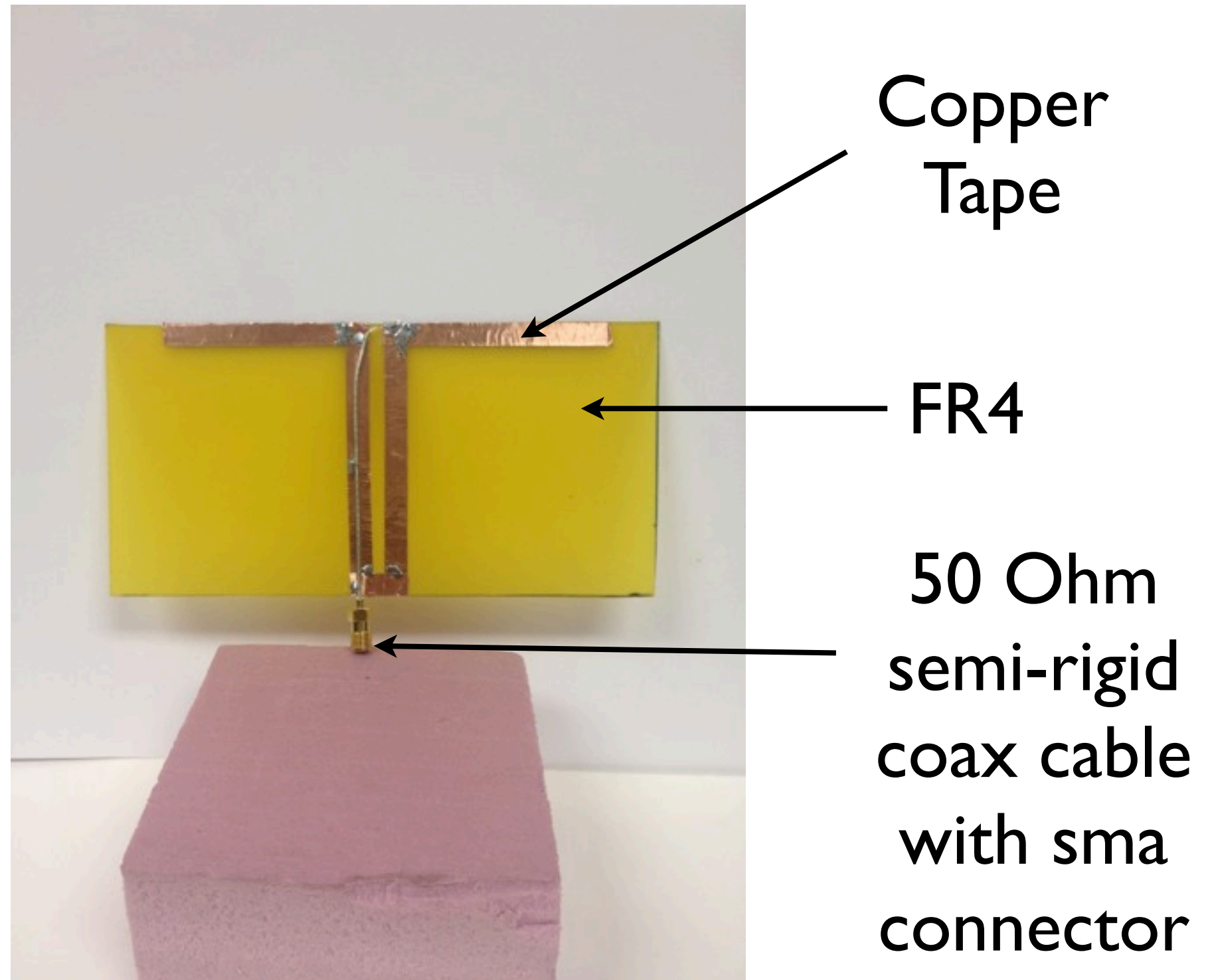


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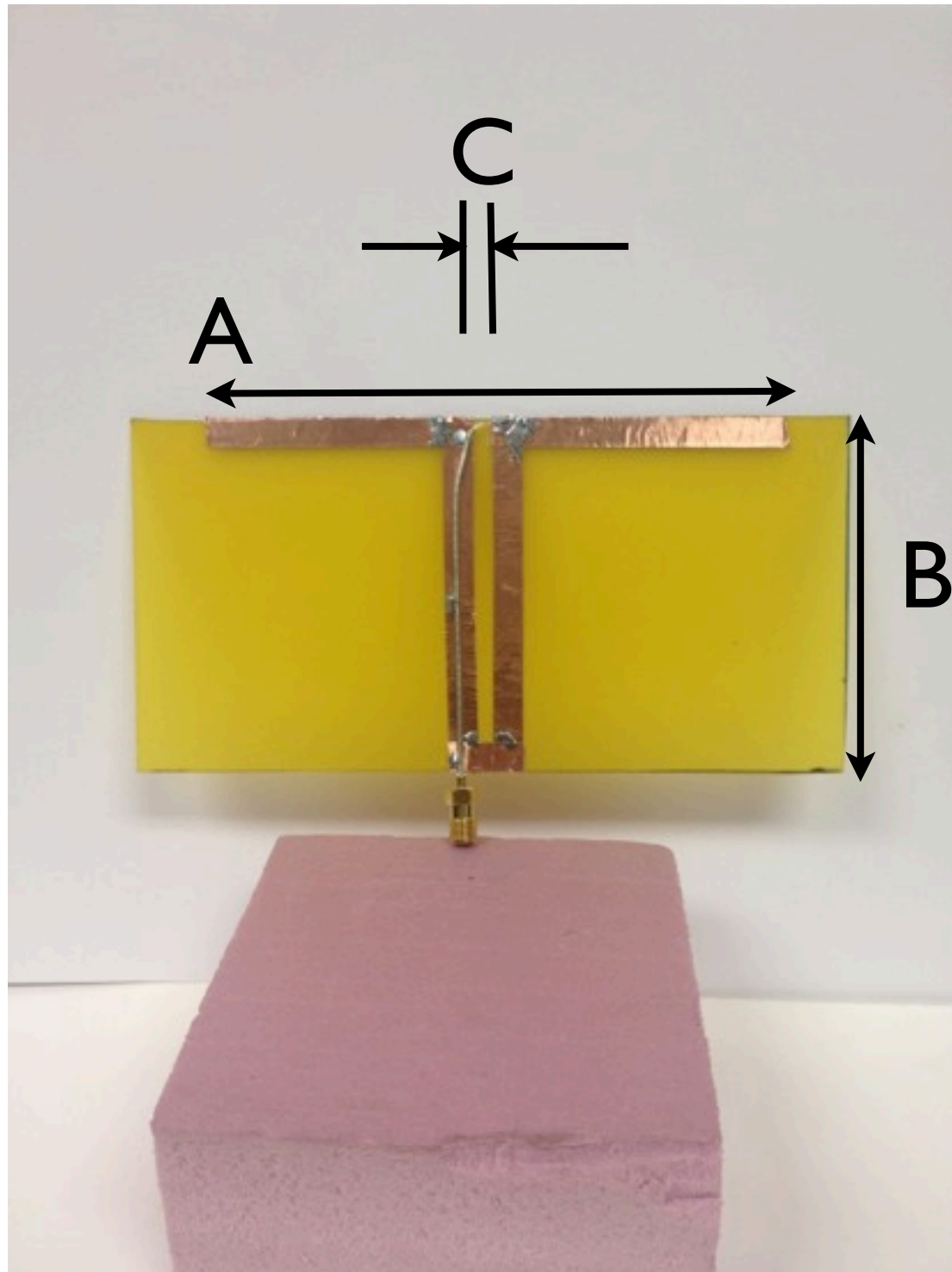
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Perpendicular DIPOLE



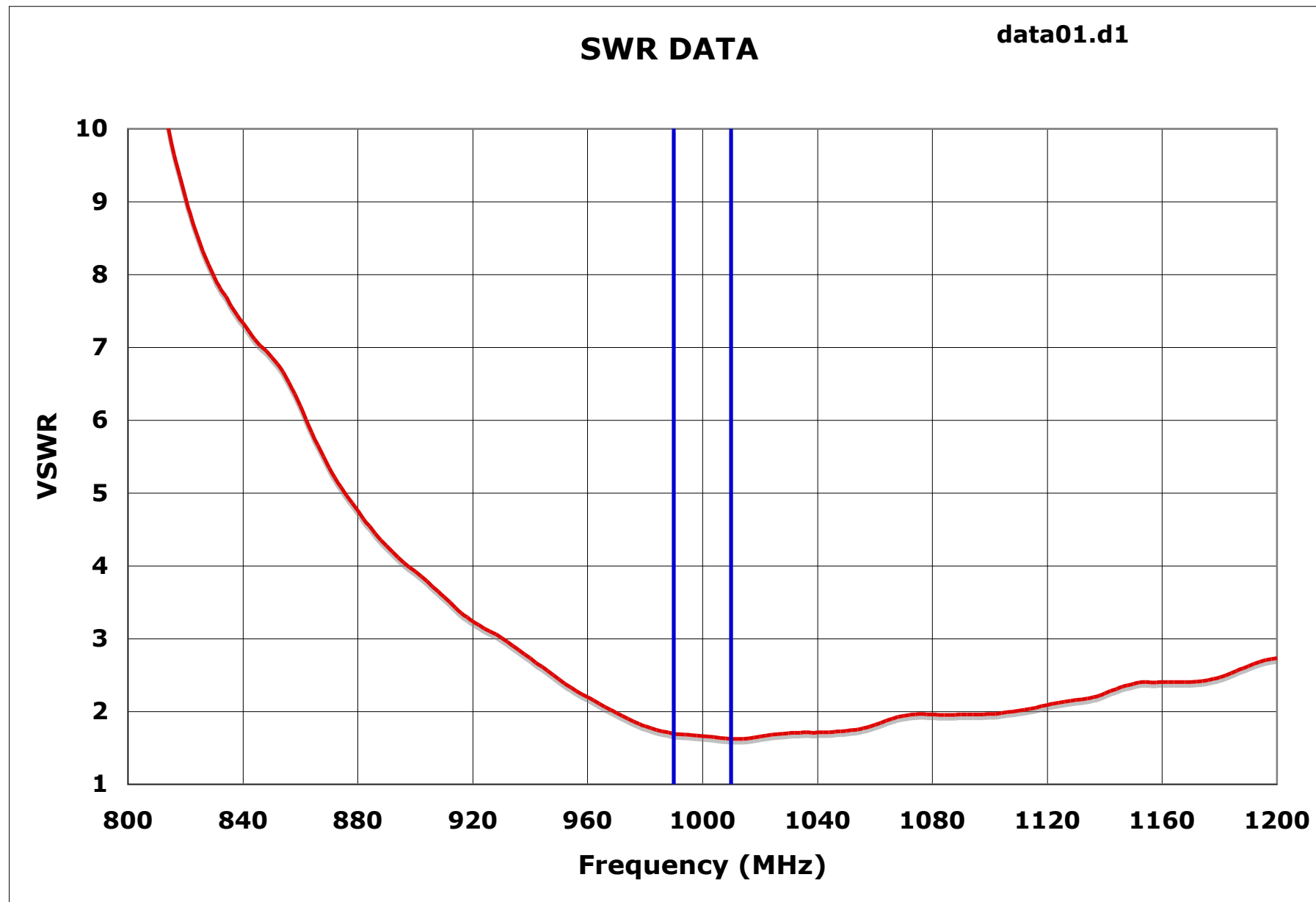
Perpendicular DIPOLE



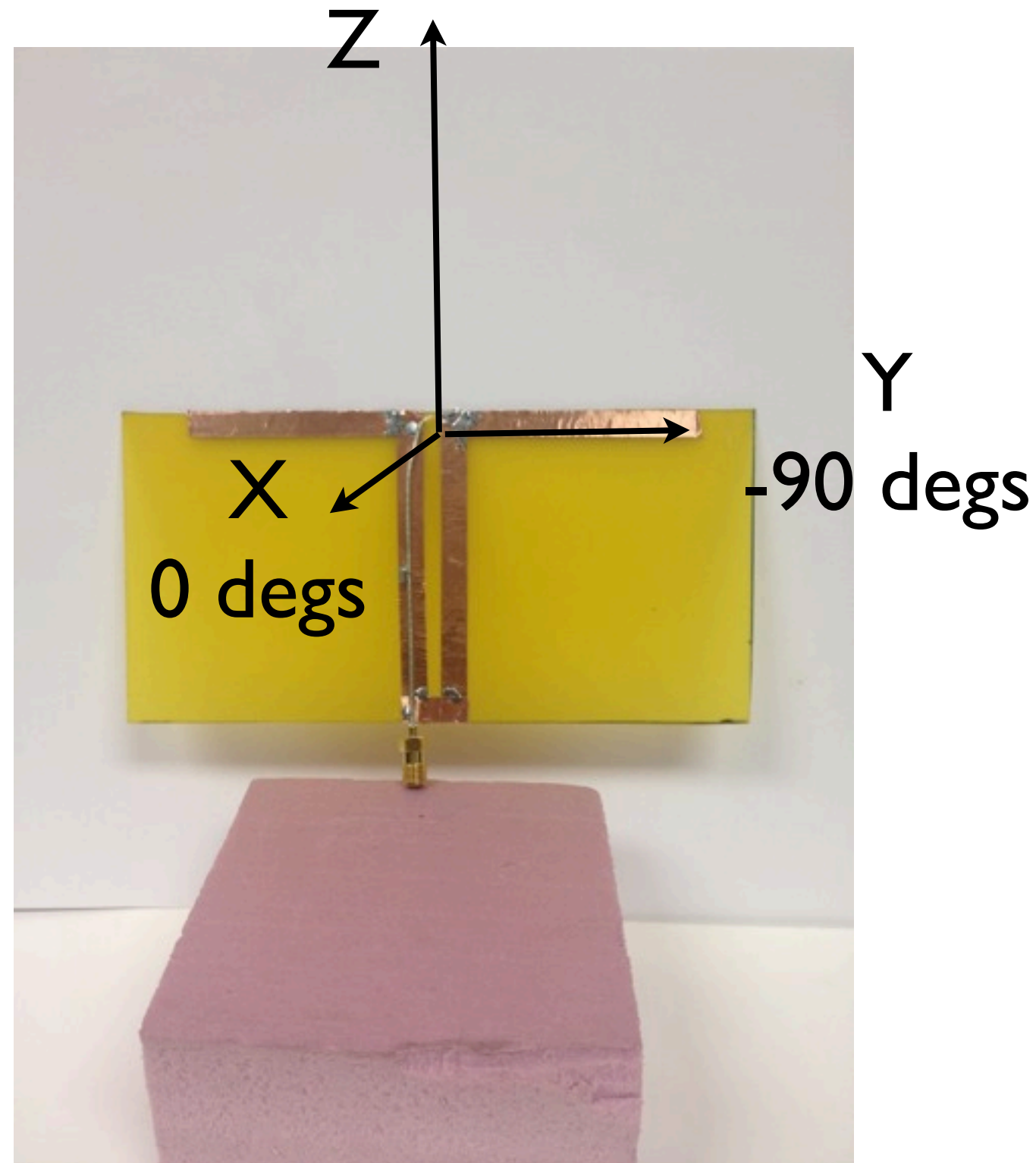
Perpendicular Dipole		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	4.80	0.40
B	3.00	0.25
C	0.20	0.02

Copper
Tape is
1/4 inch
width

Perpendicular DIPOLE: VSWR



Pattern Orientation

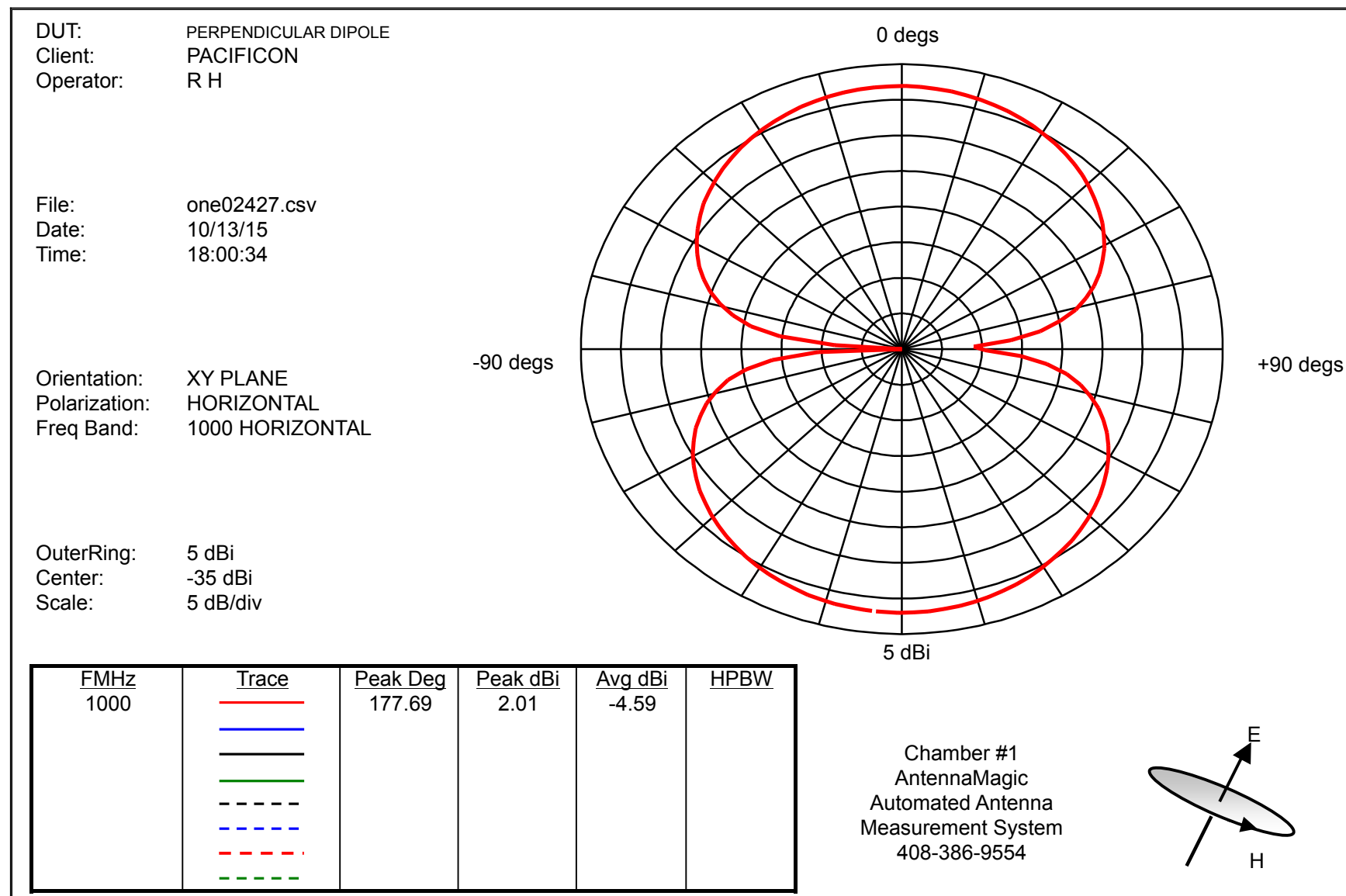


Perpendicular DIPOLE: Pattern

Antenna Radiation Pattern

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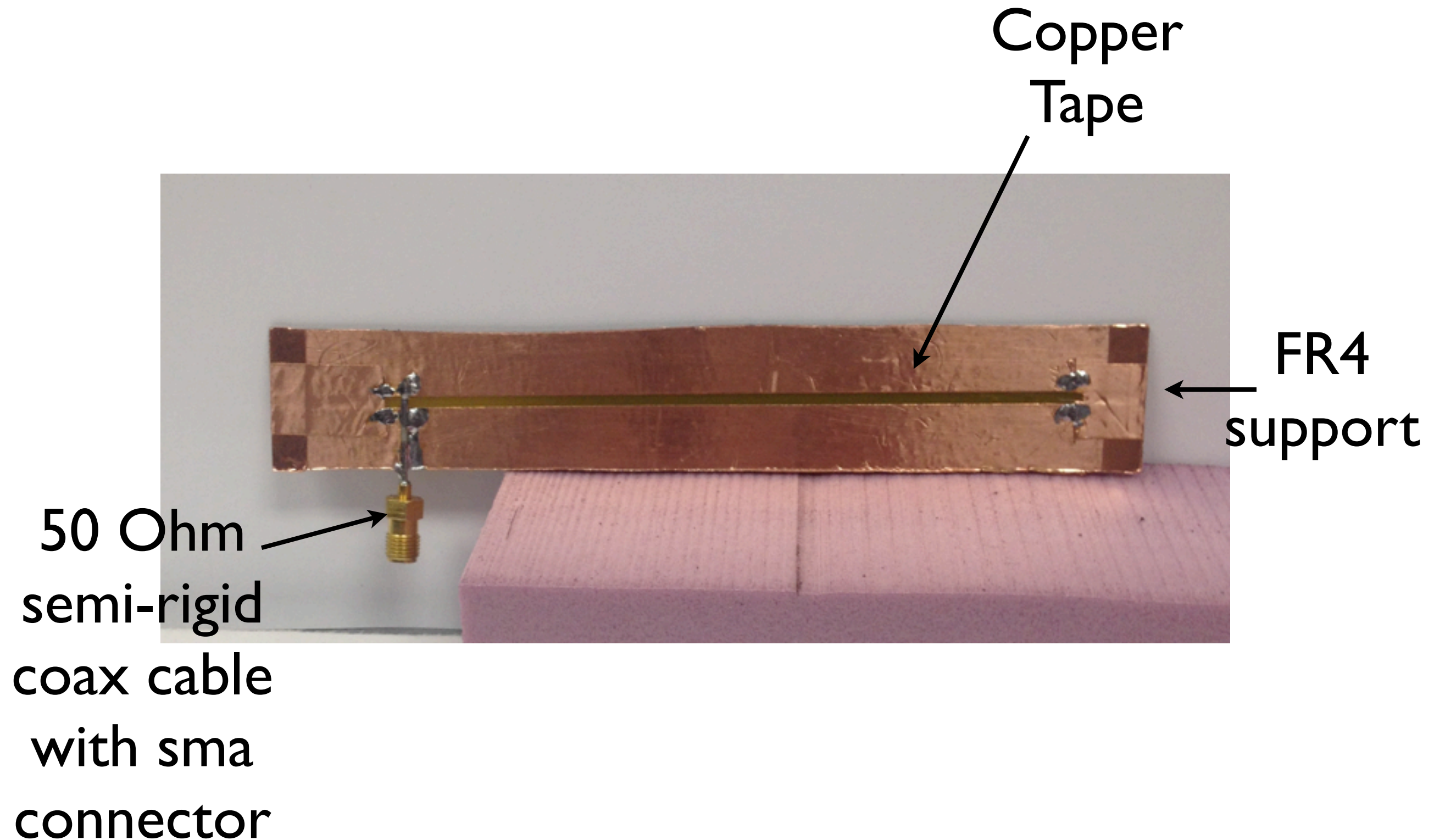


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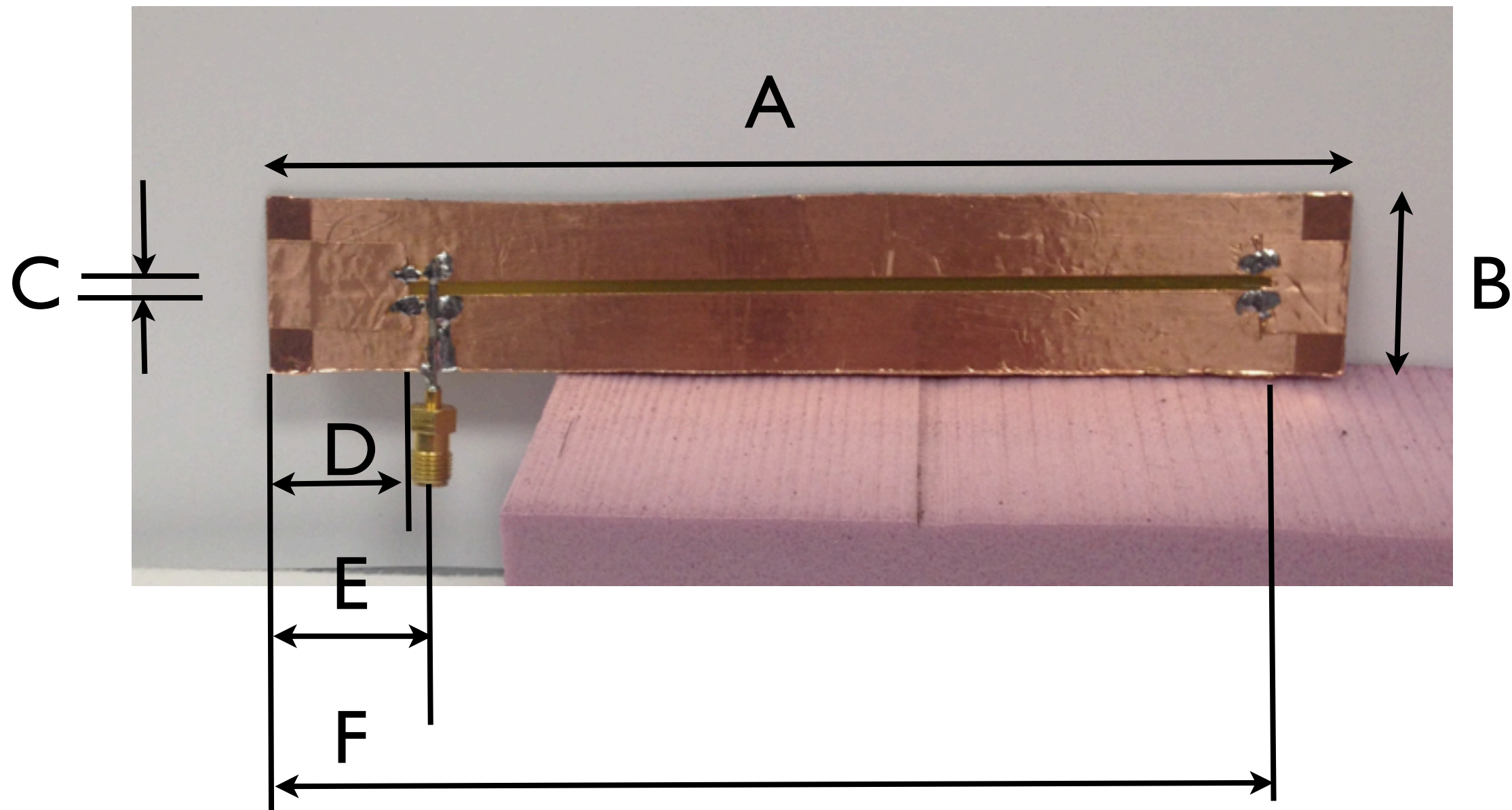
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Slot Antenna

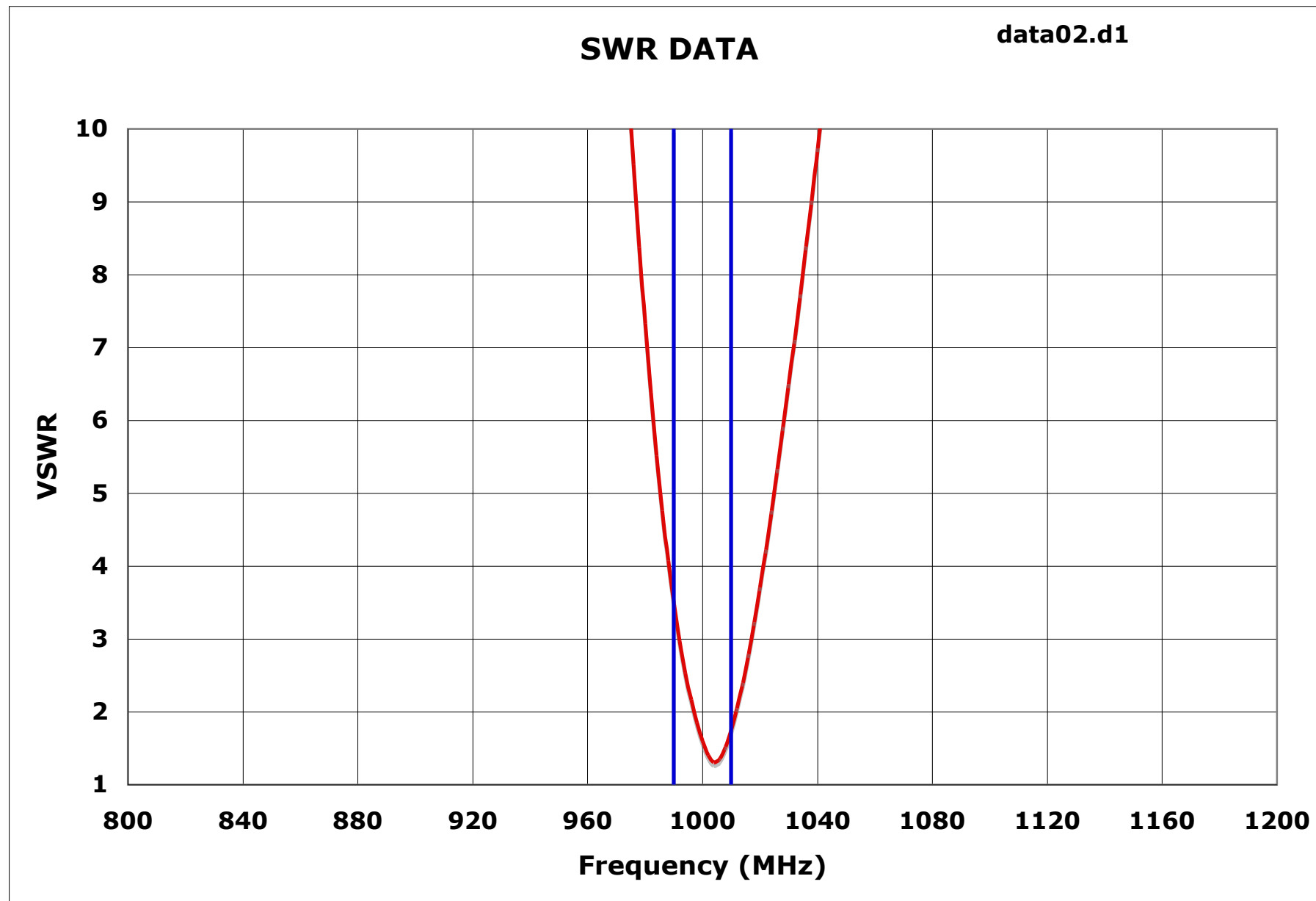


Slot Antenna

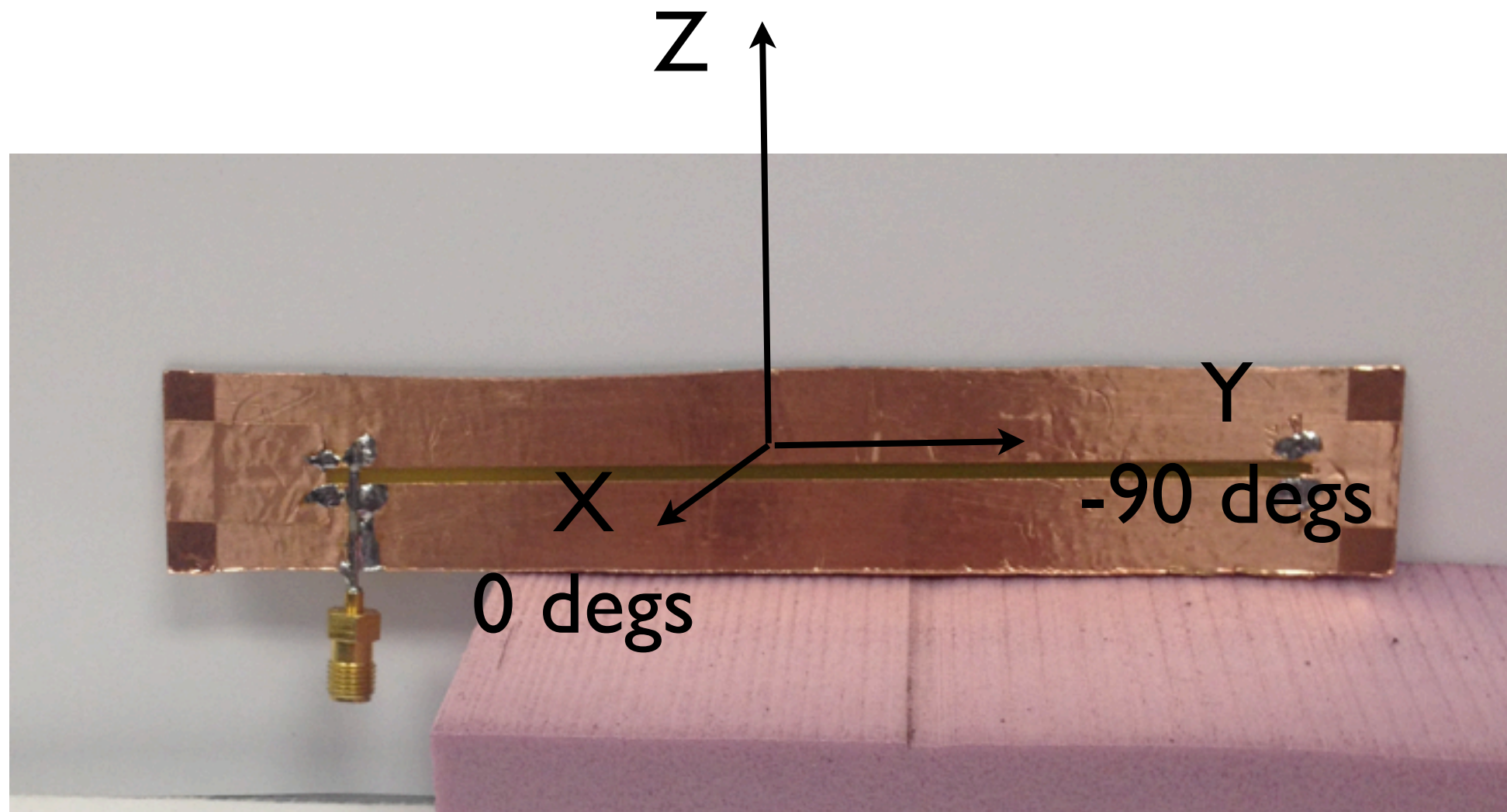
Slot Antenna		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	6.00	0.50
B	1.00	0.08
C	0.10	0.01
D	0.80	0.07
E	1.00	0.08
F	5.50	0.46



Slot Antenna: VSWR



Pattern Orientation

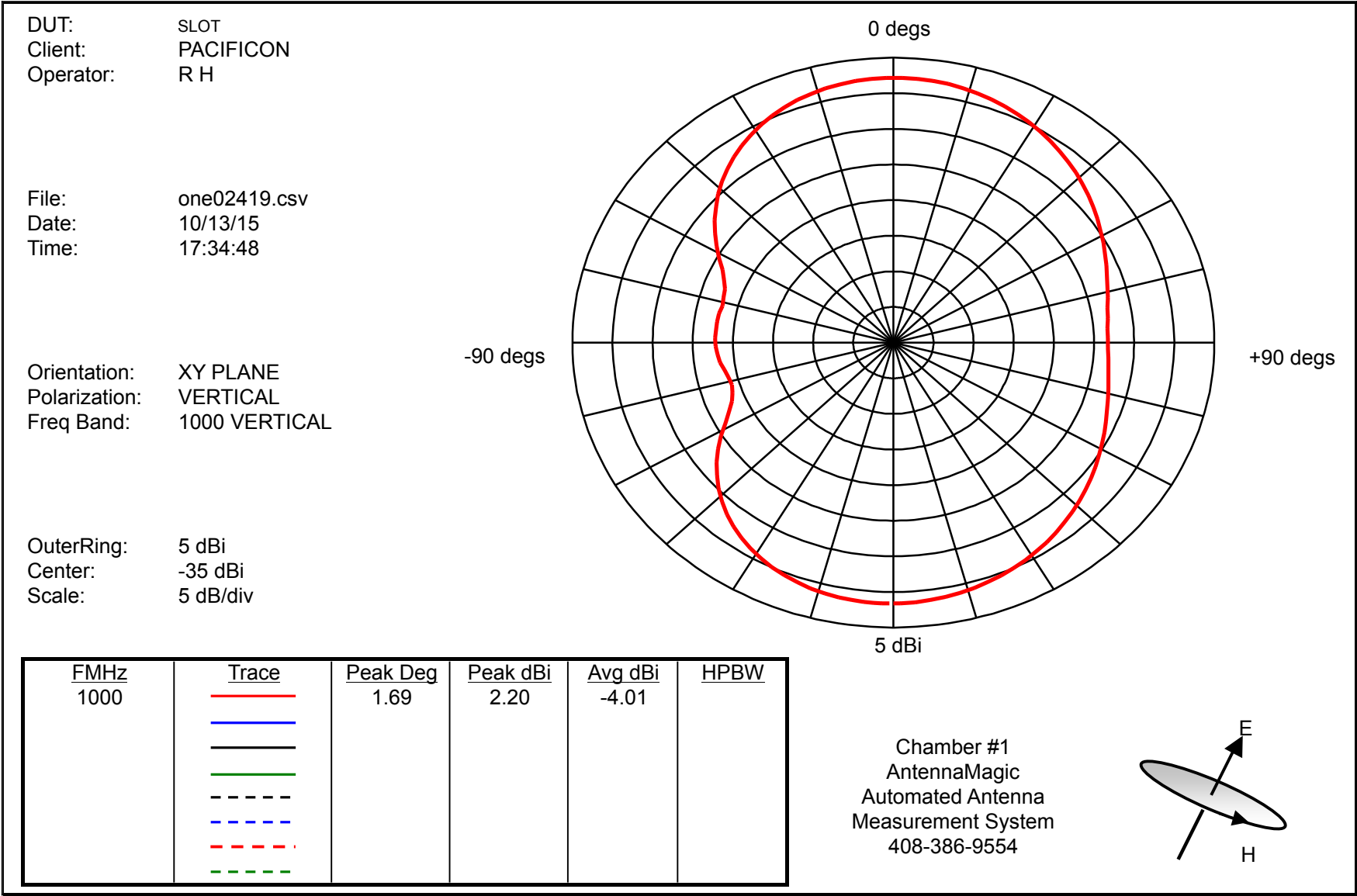


Slot Antenna: Pattern

Antenna Radiation Pattern

MagicPlots.xls

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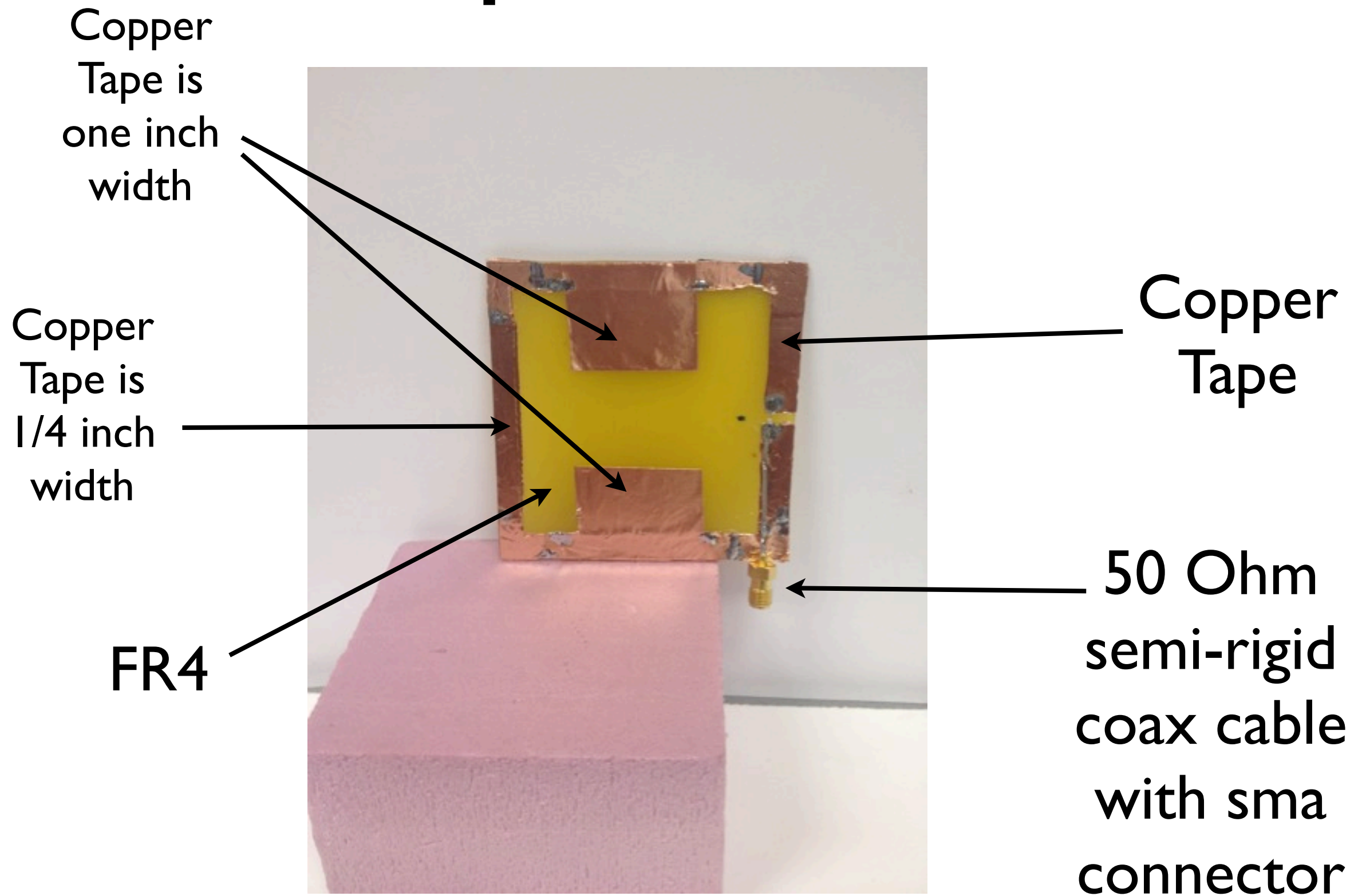


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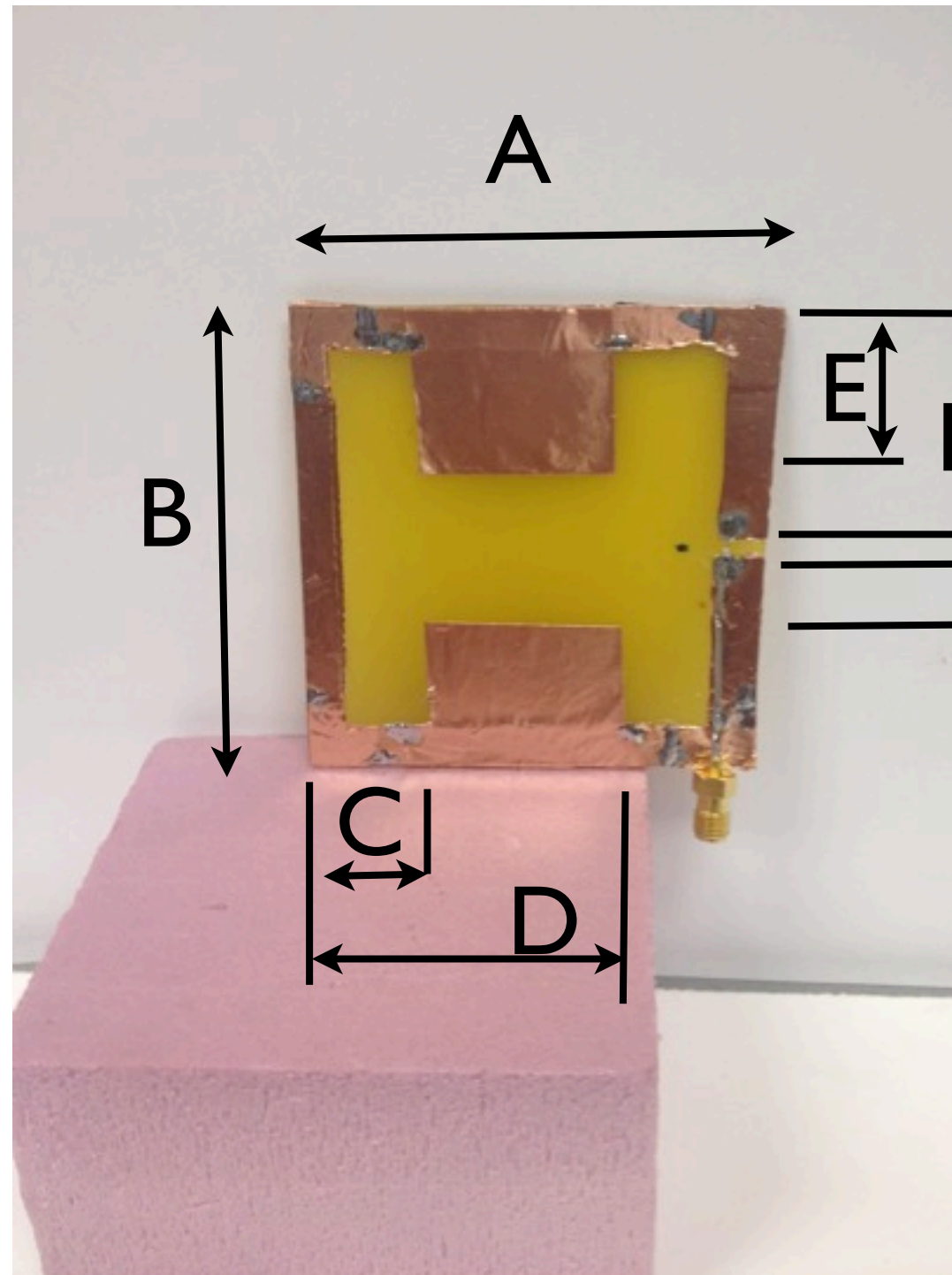
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Loop Antenna

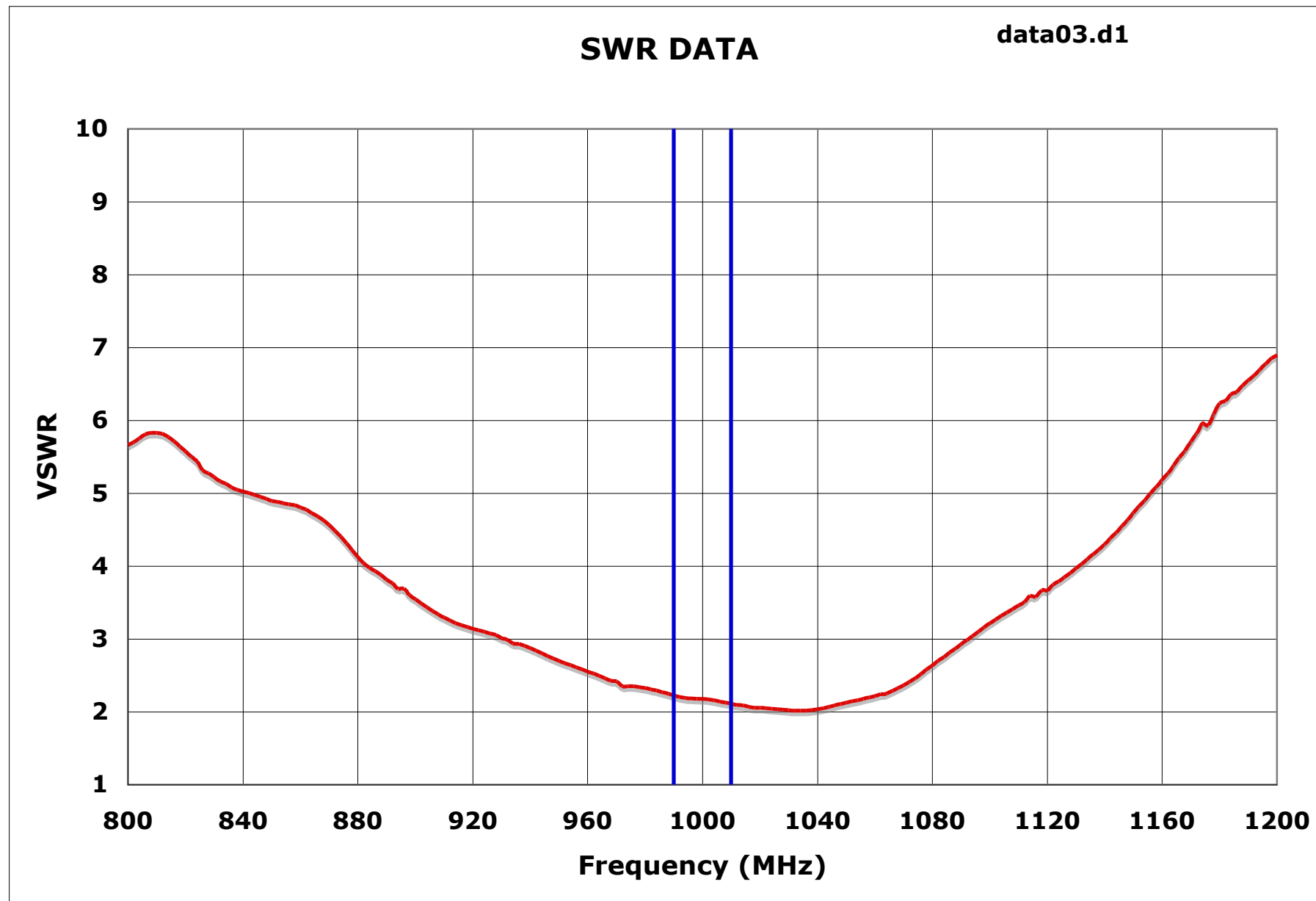


Loop Antenna

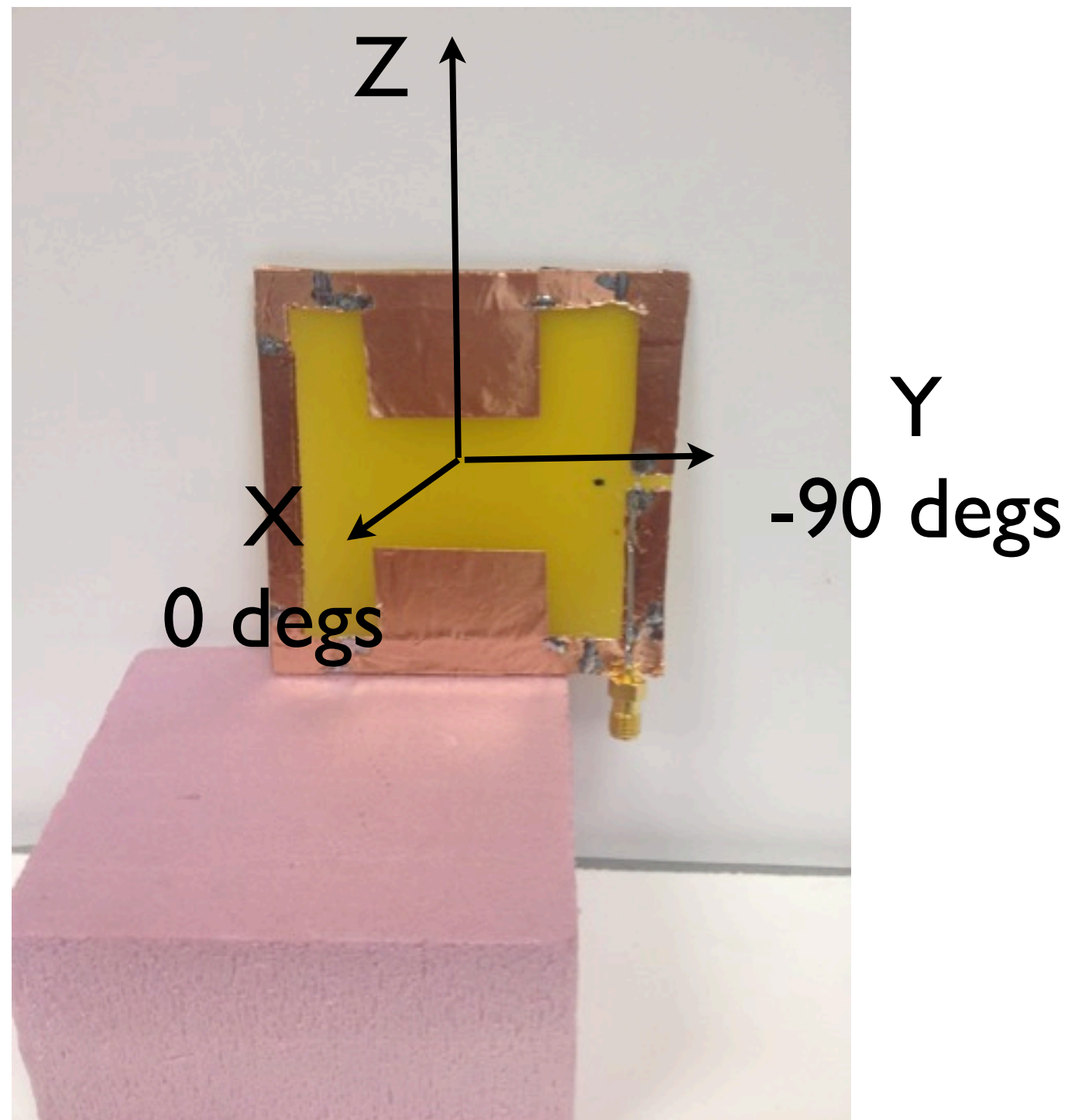


Loop Antenna		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	3.00	0.25
B	3.00	0.25
C	0.80	0.07
D	2.10	0.18
E	1.00	0.08
F	1.40	0.12
G	1.50	0.13
H	2.00	0.17

Loop Antenna: VSWR



Vertical Polarization Pattern Orientation

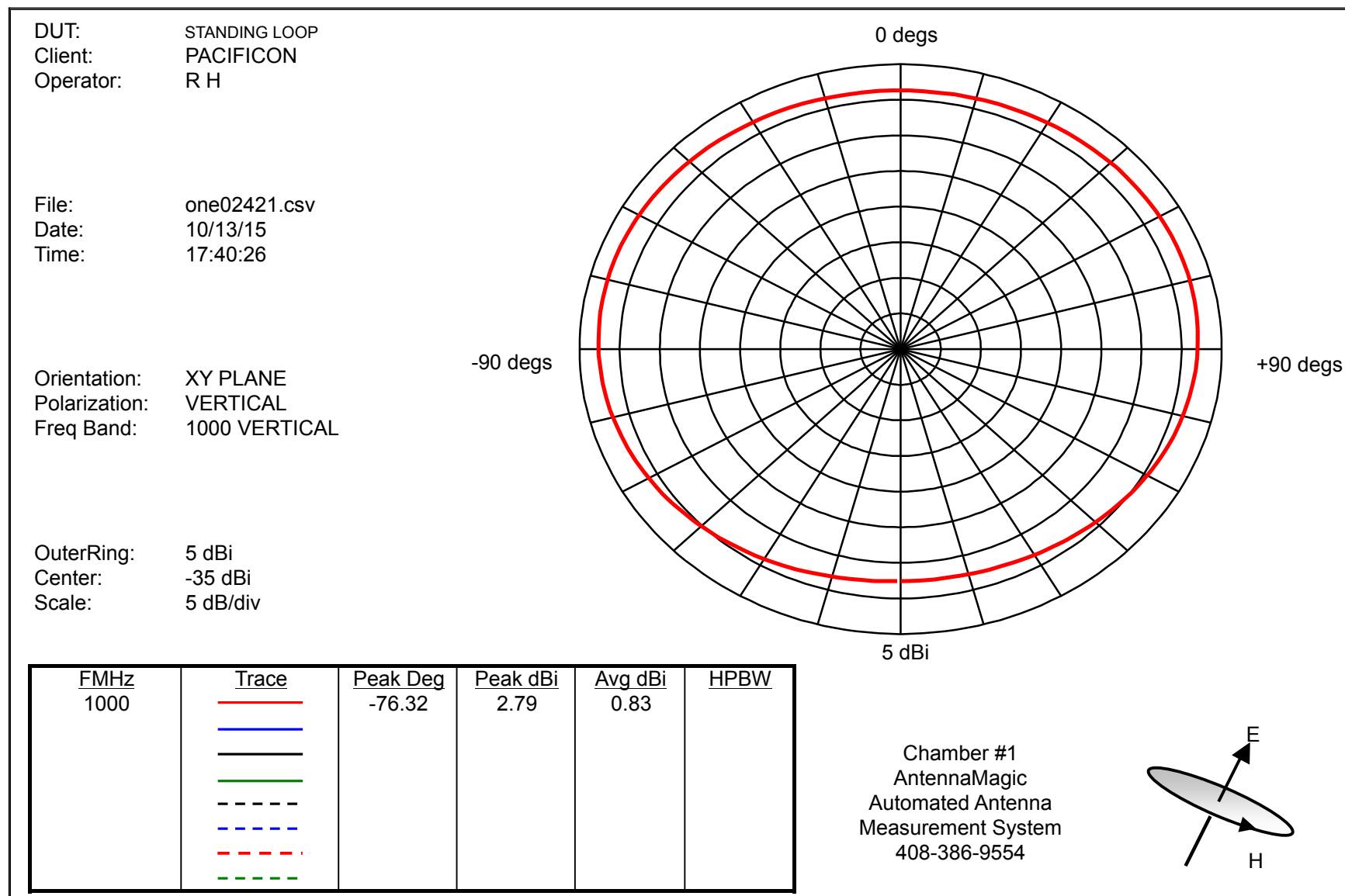


Loop Antenna: Vertical Pattern

Antenna Radiation Pattern

MagicPlots.xls

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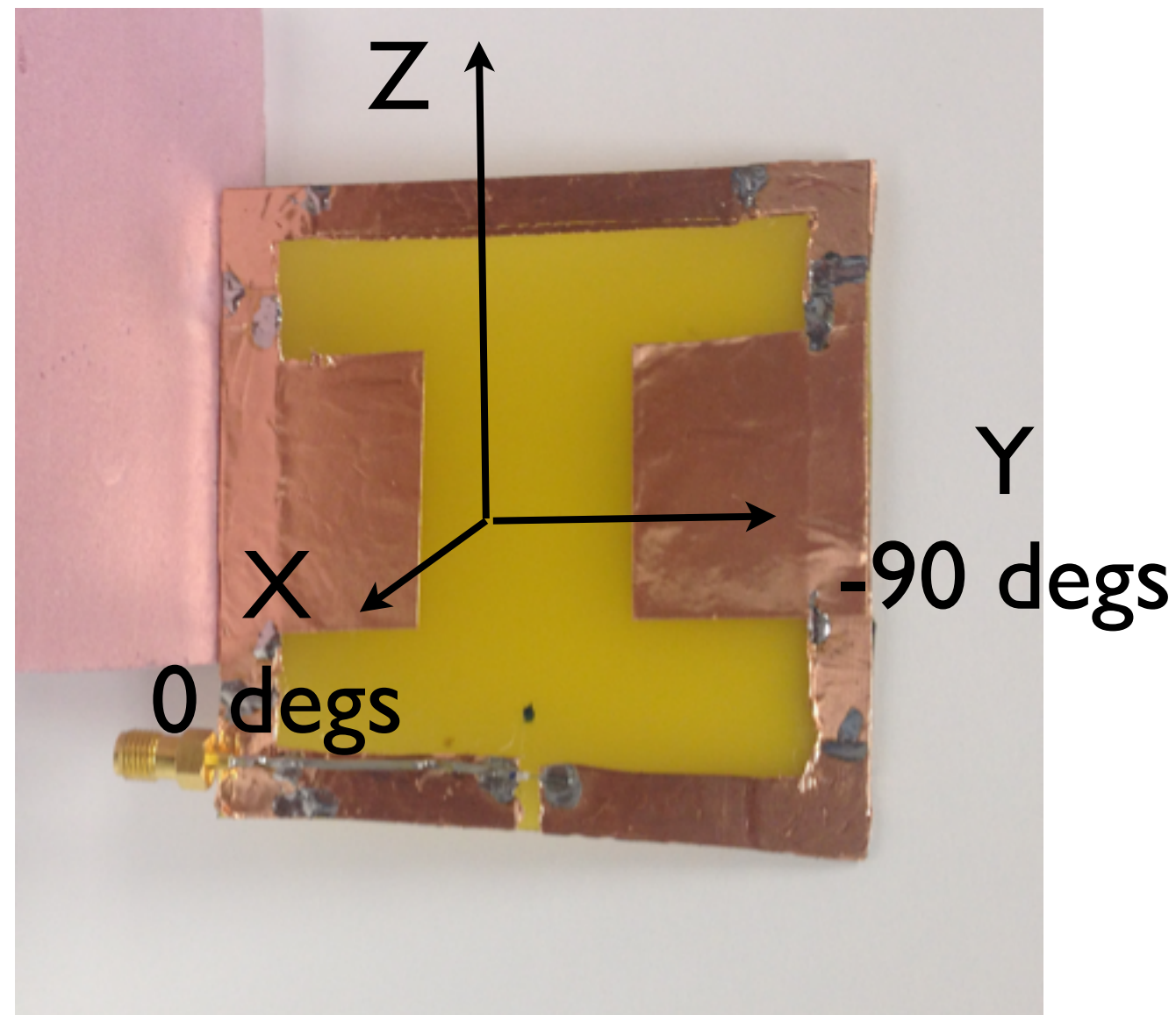


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Horizontal Polarization Pattern Orientation

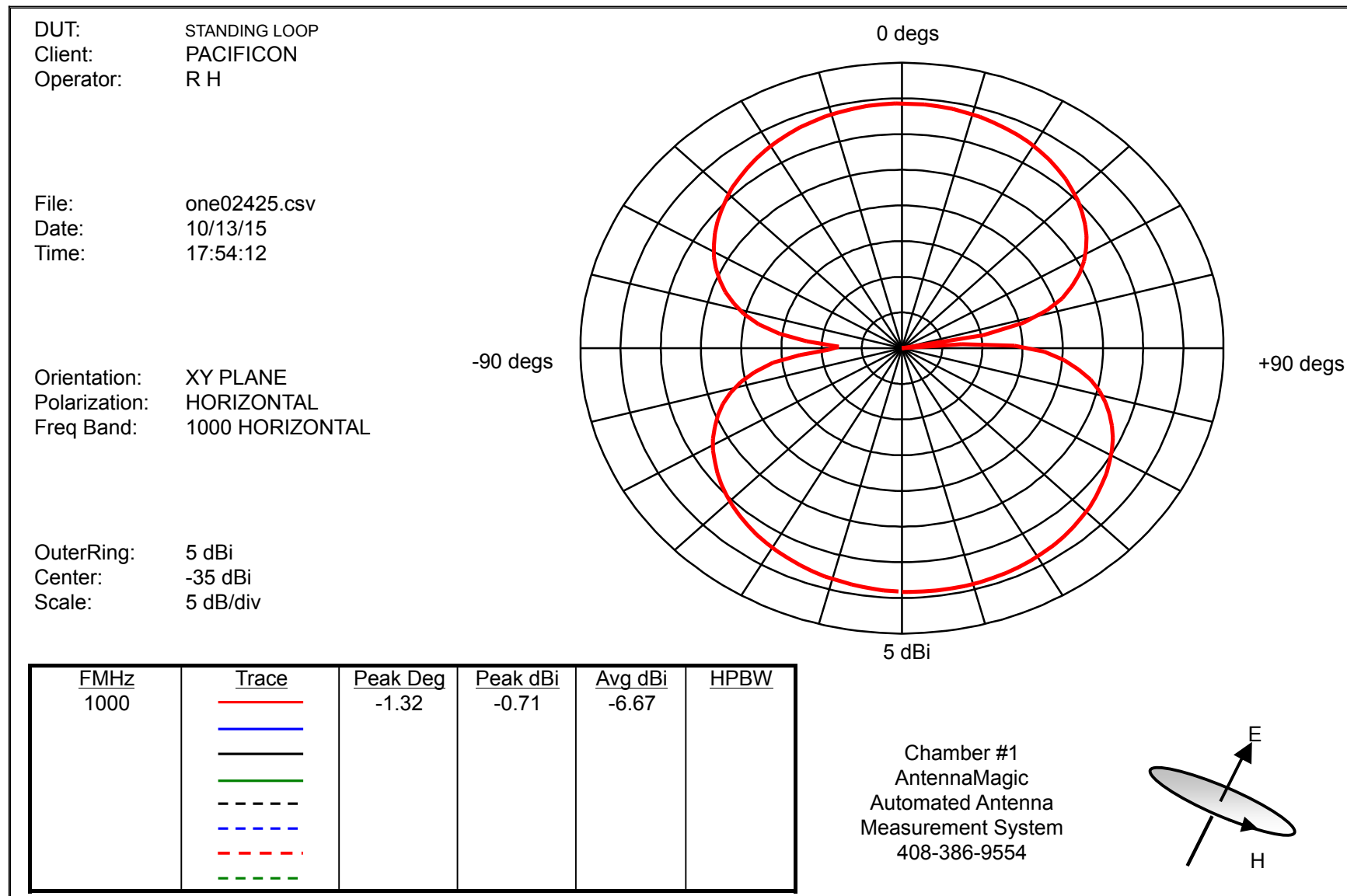


Loop Antenna: Horizontal Pattern

Antenna Radiation Pattern

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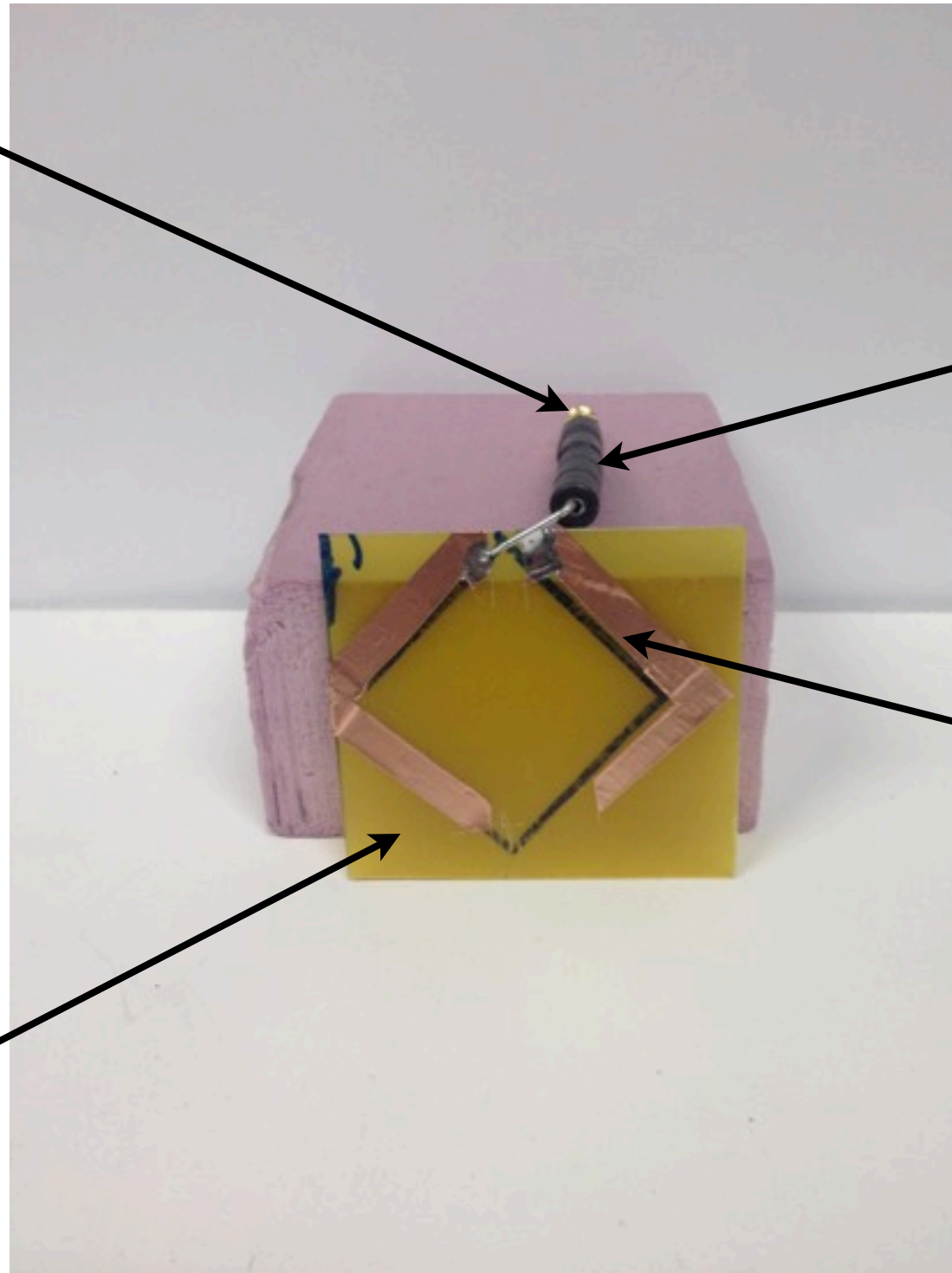
Doop Antenna

50 Ohm
semi-rigid
coax cable
with sma
connector

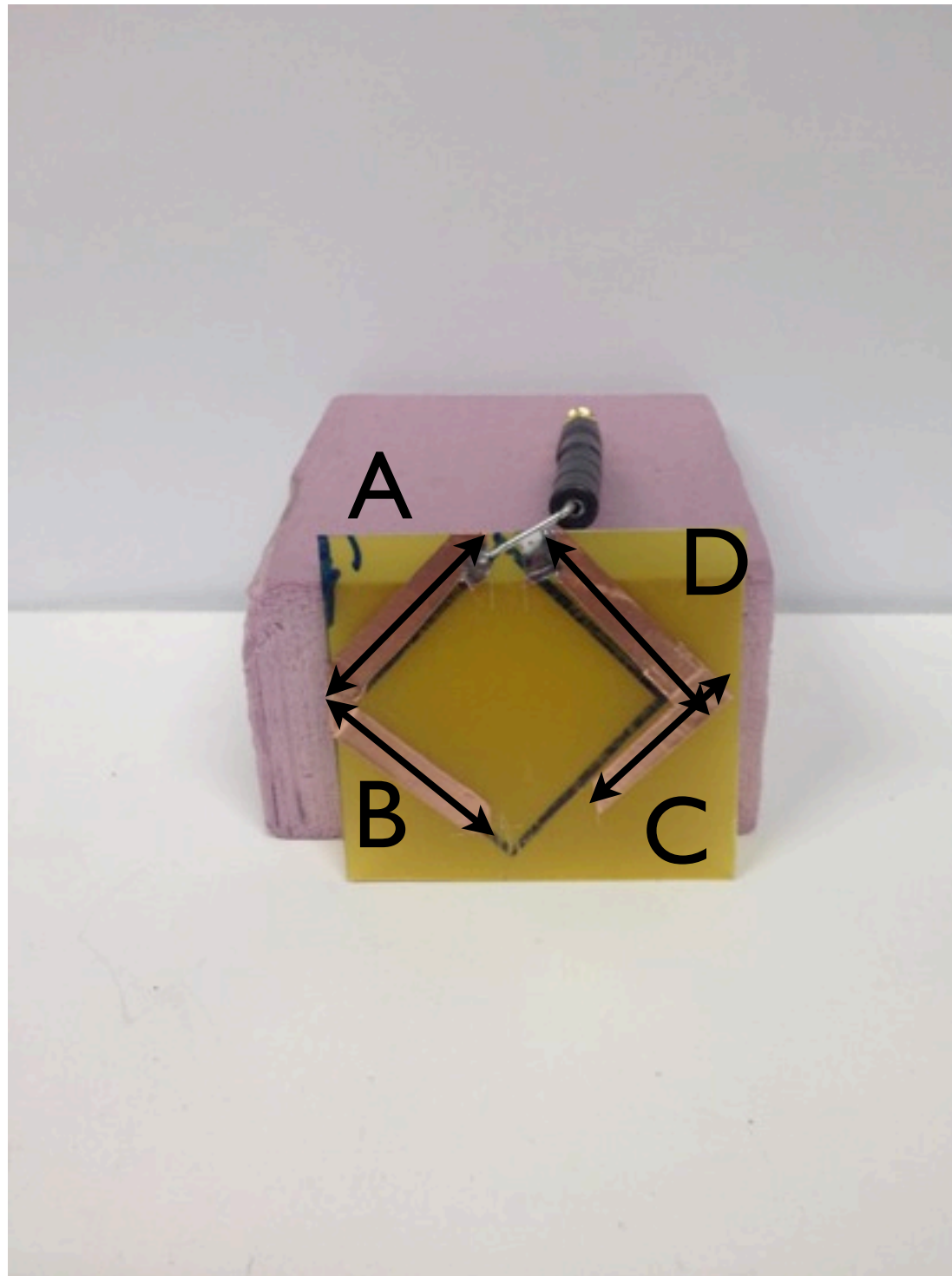
Ferrite
Beads
on Coax

1/4"
Copper
Tape

FR4

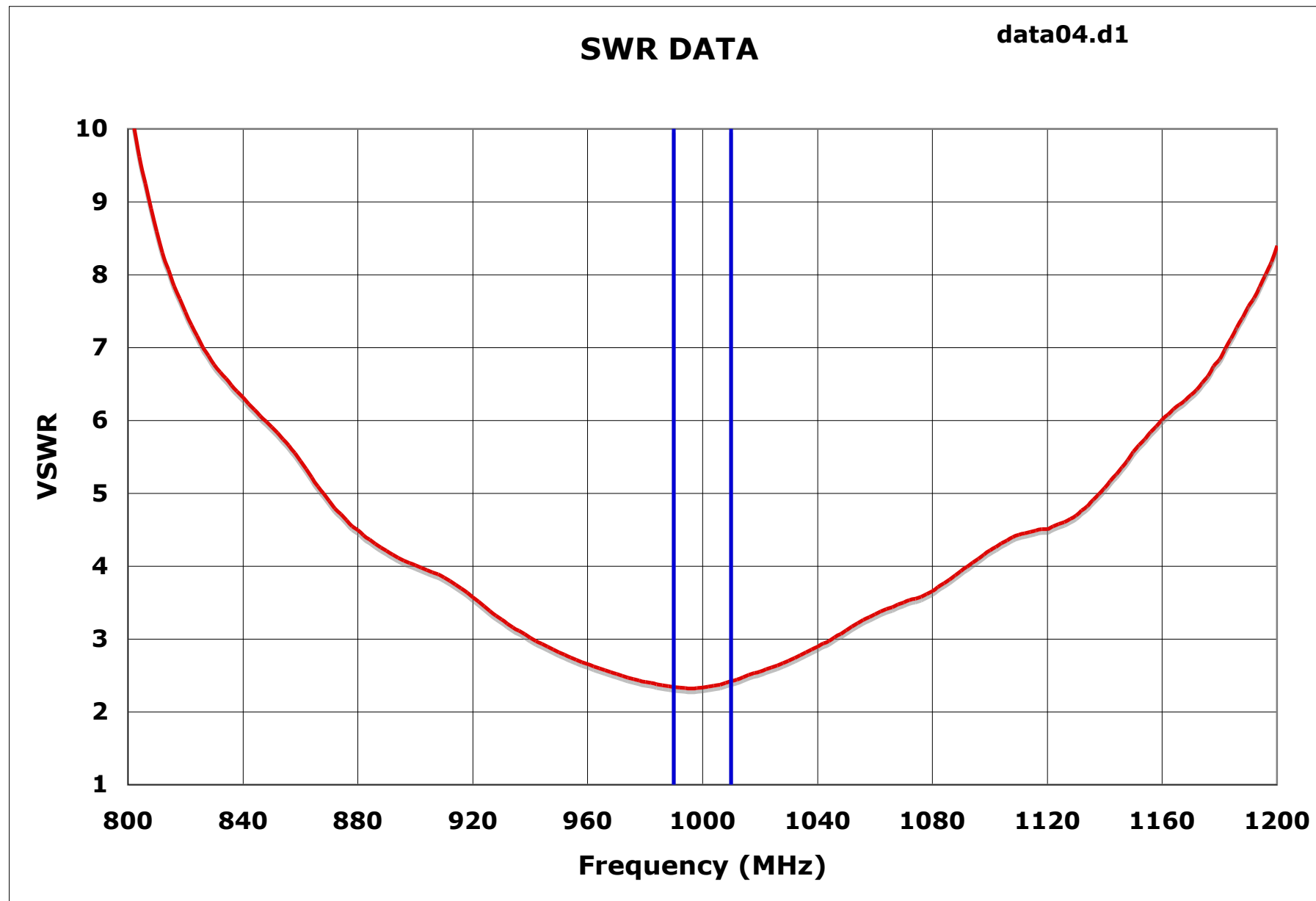


Doop Antenna

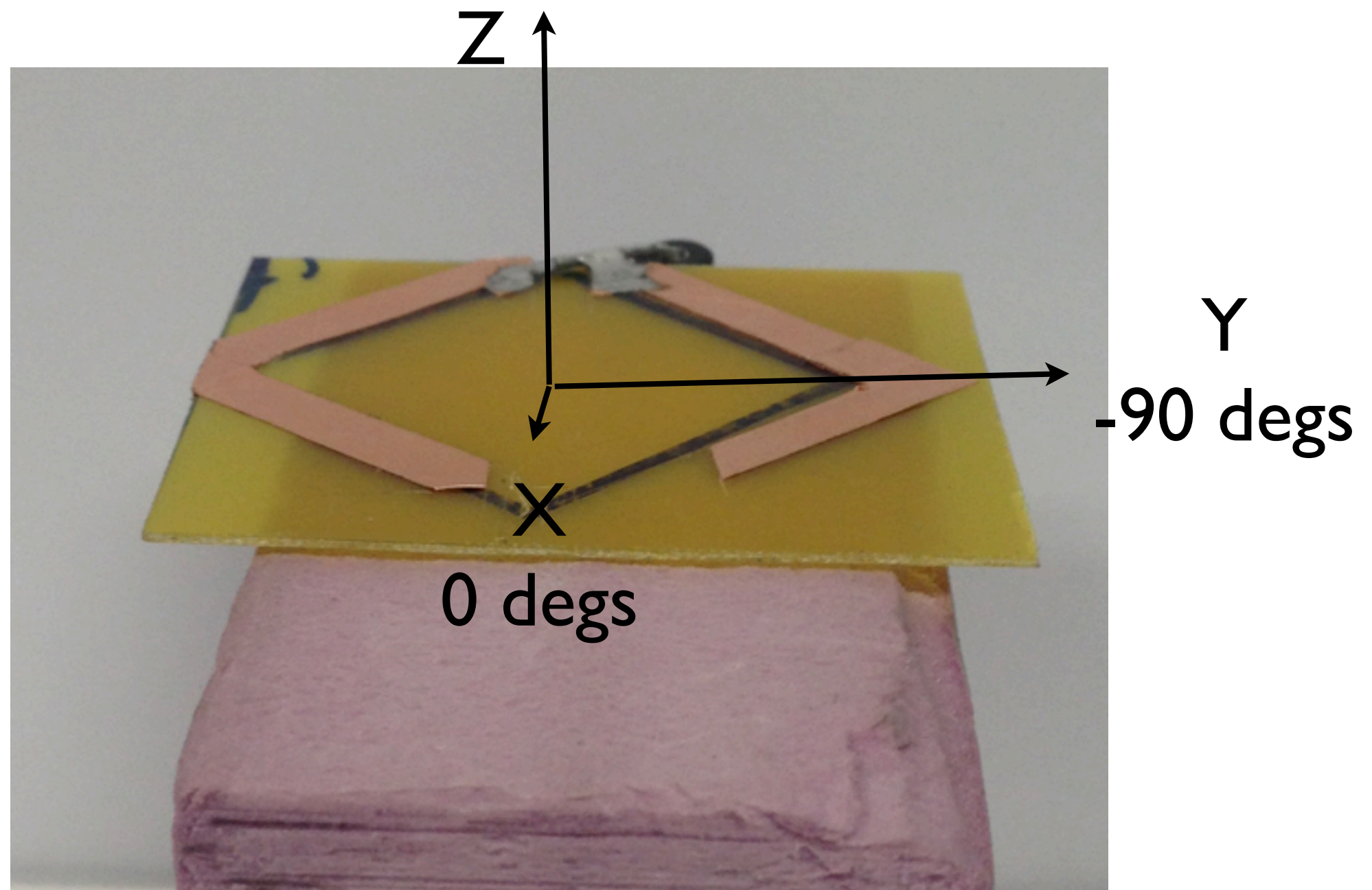


Doop Antenna		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	1.50	0.125
B	1.30	0.108
C	1.10	0.092
D	1.60	0.133

Doop Antenna: VSWR



Horizontal Polarization Pattern Orientation

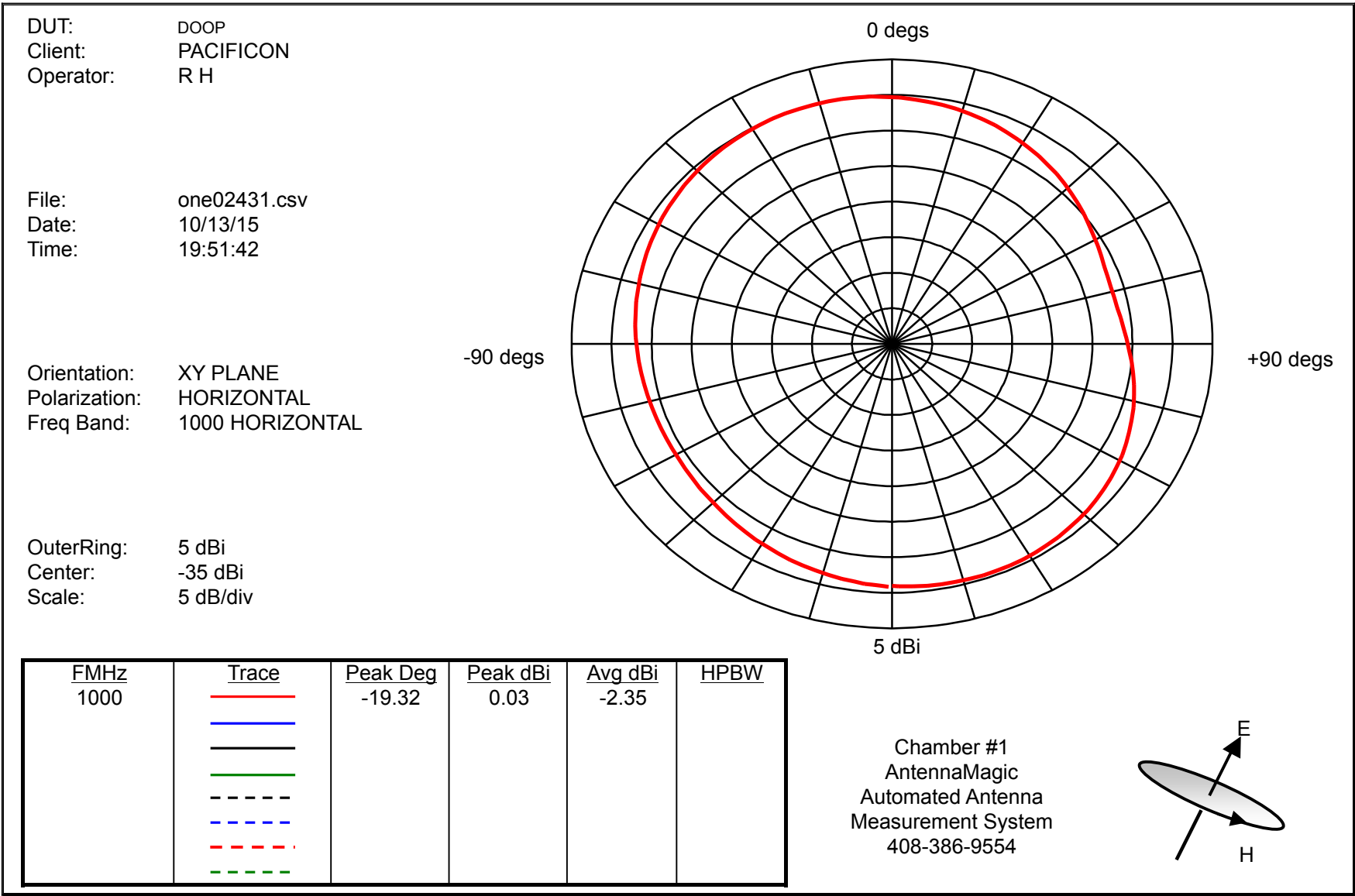


Doop Antenna: Pattern

Antenna Radiation Pattern

MagicPlots.xls

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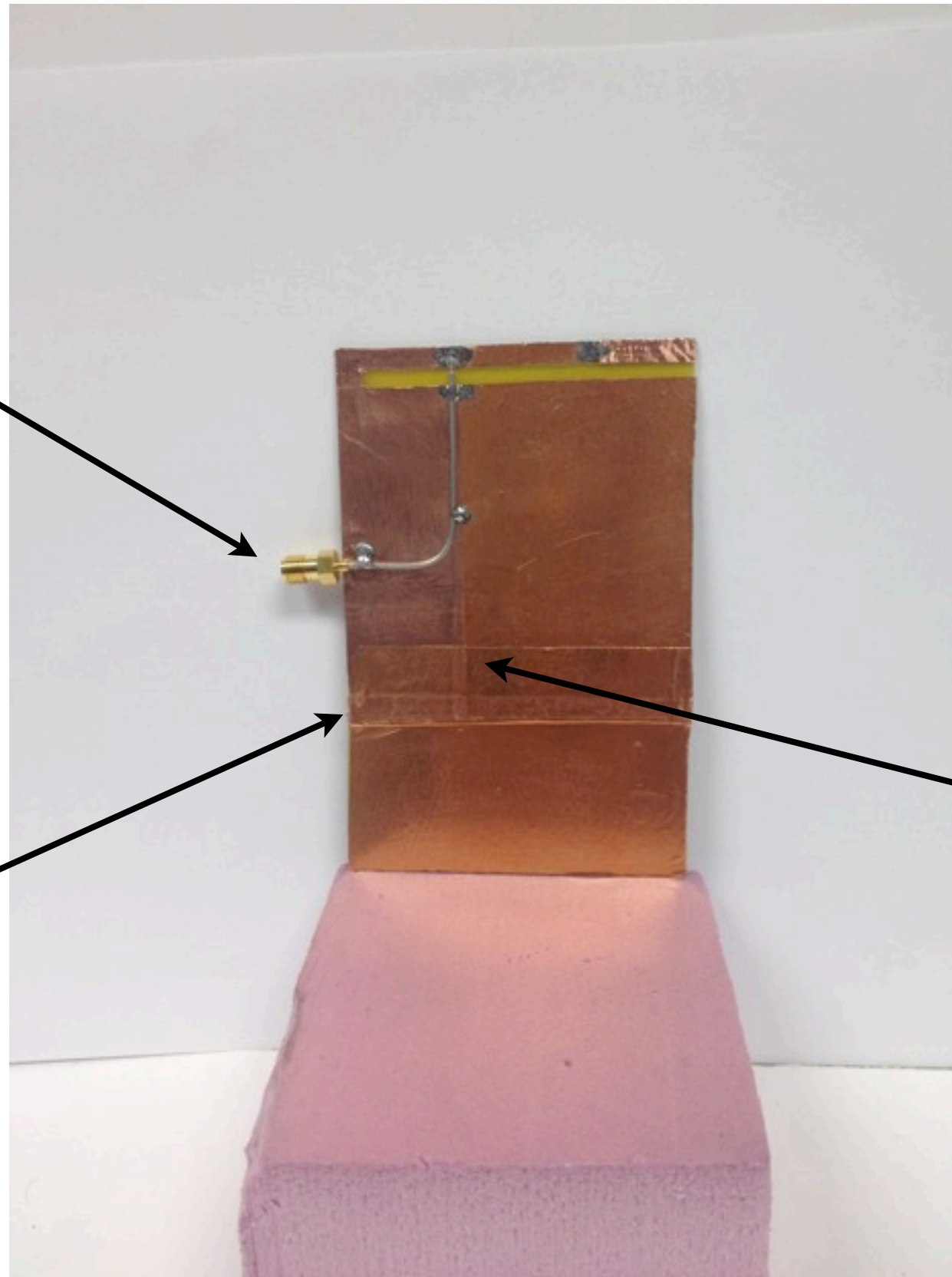
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IFA Antenna

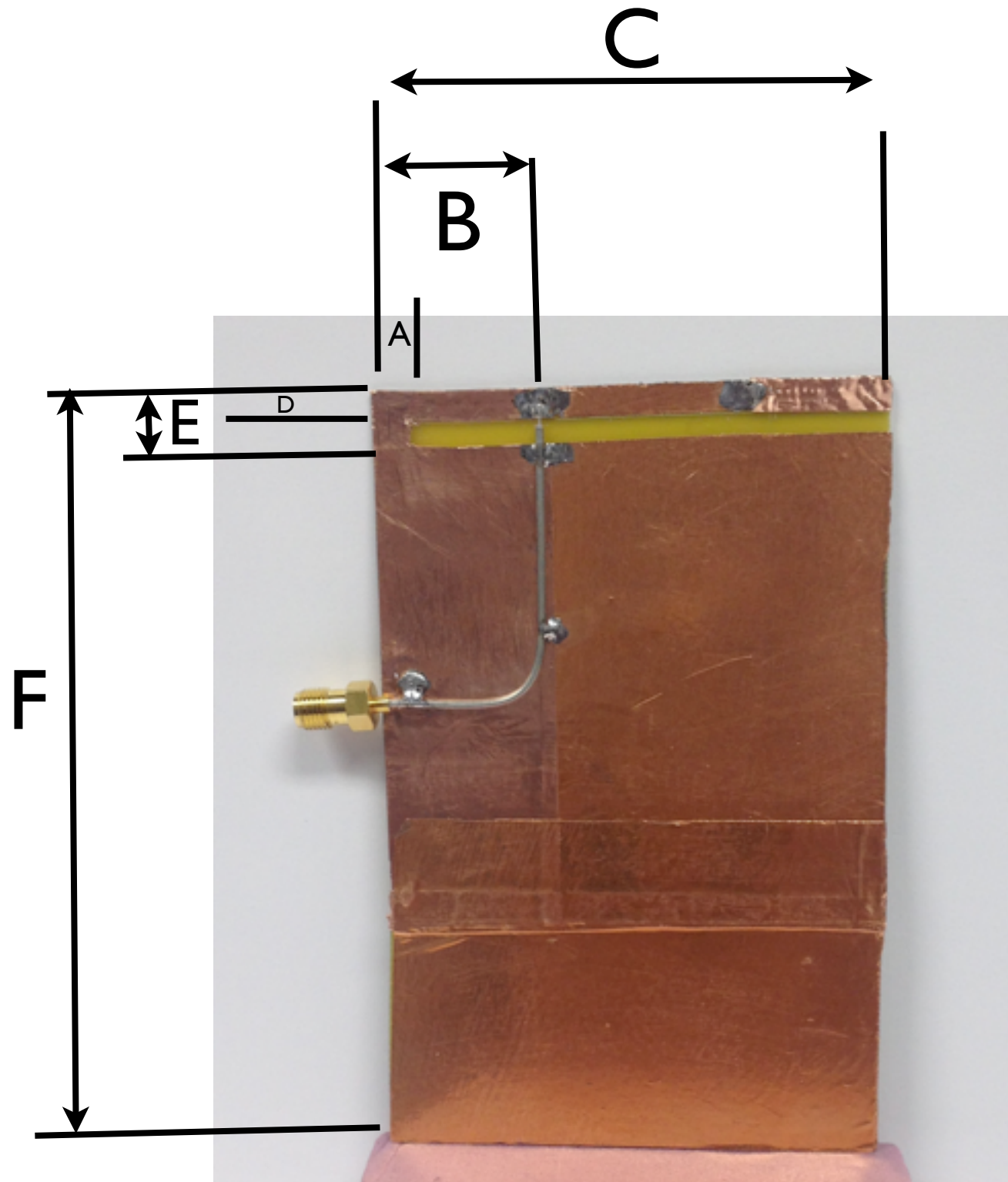
50 Ohm
semi-rigid
coax cable
with sma
connector

FR4
Support

Copper
Tape

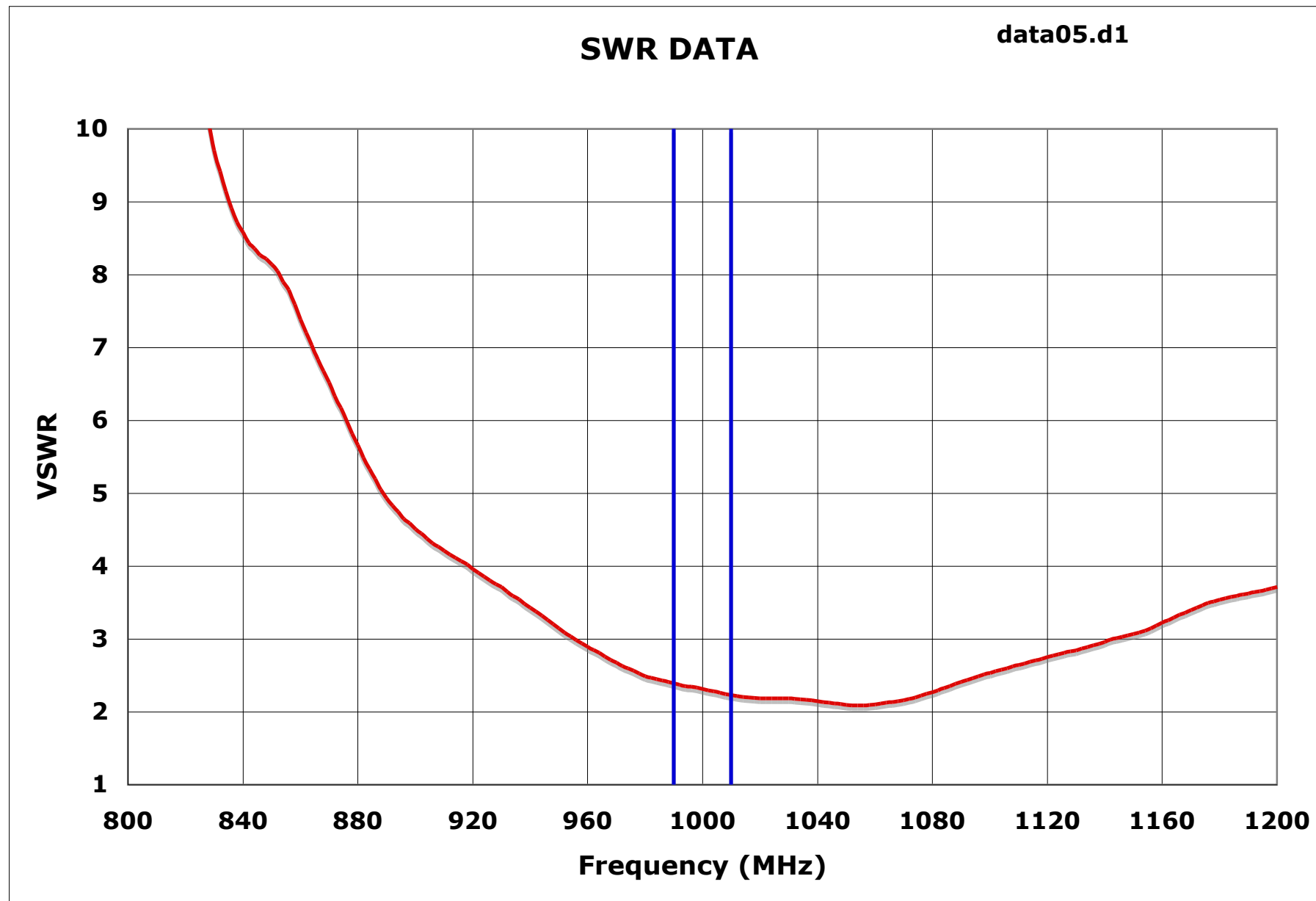


IFA Antenna

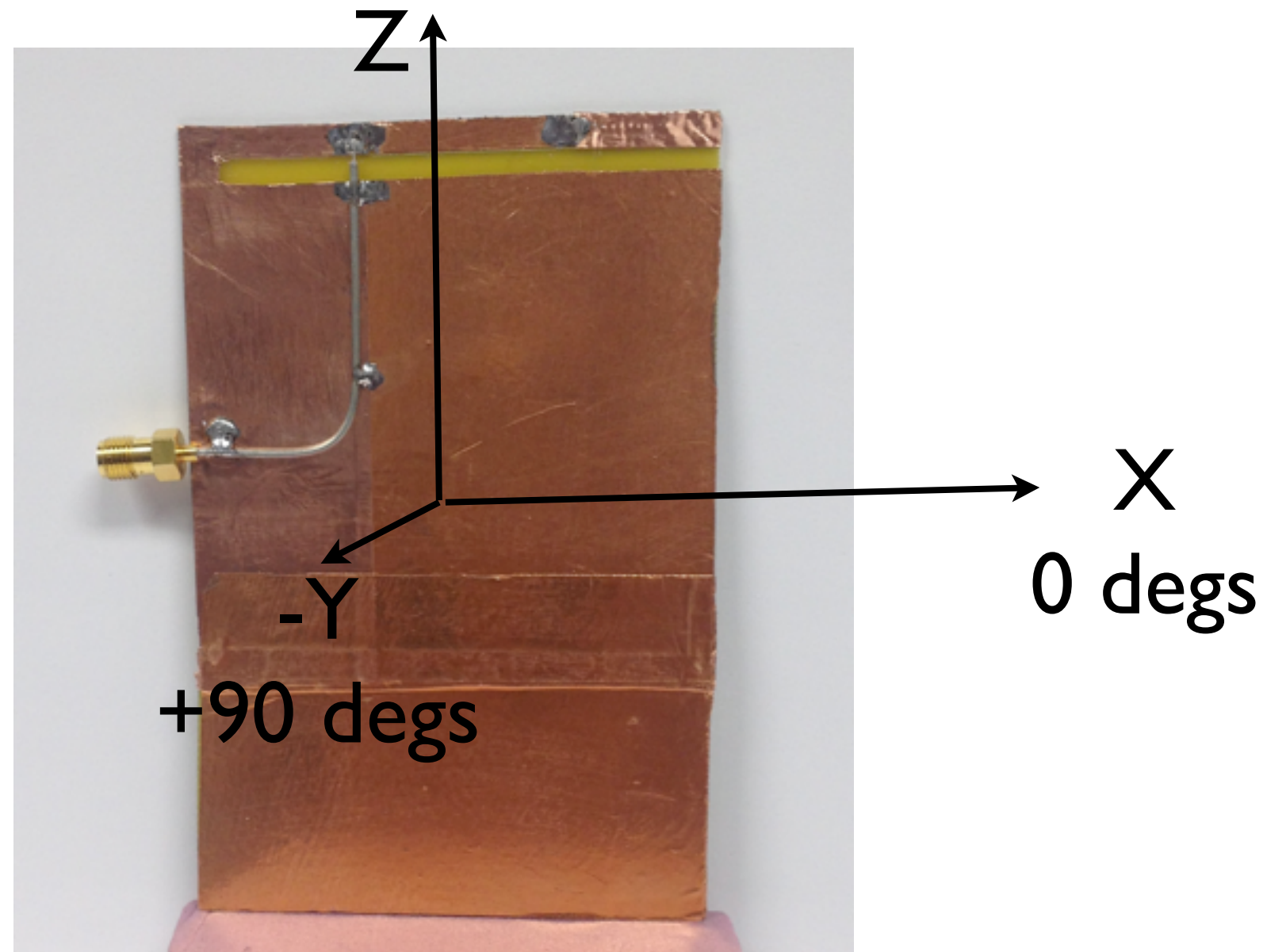


Inverted F Antenna (IFA)		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	0.20	0.017
B	1.00	0.083
C	3.00	0.250
D	0.15	0.013
E	0.15	0.013
F	4.40	0.367

IFA Antenna: VSWR



Vertical Polarization Pattern Orientation

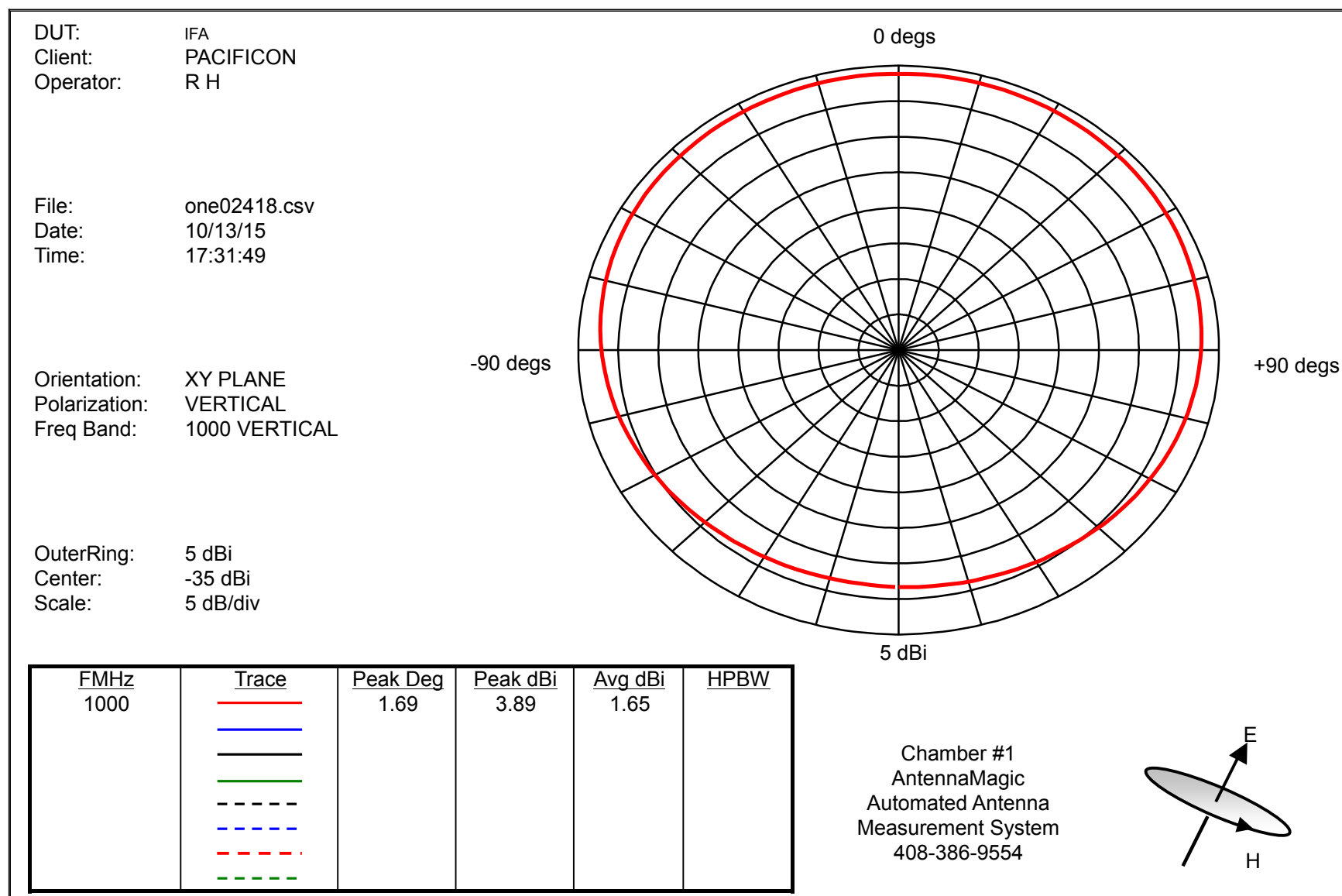


IFA Antenna: Vertical Pattern

Antenna Radiation Pattern

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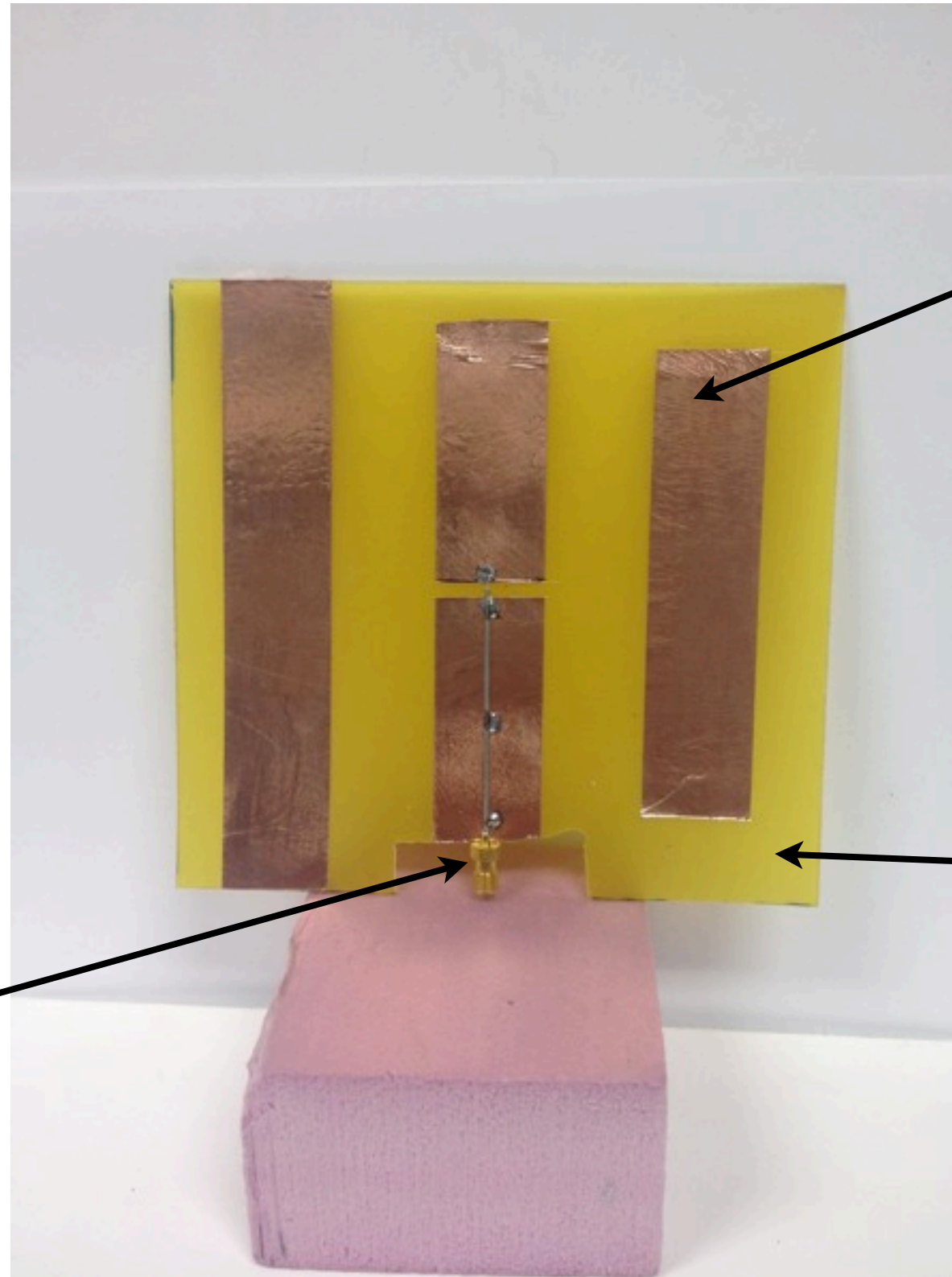
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Yagi Antenna

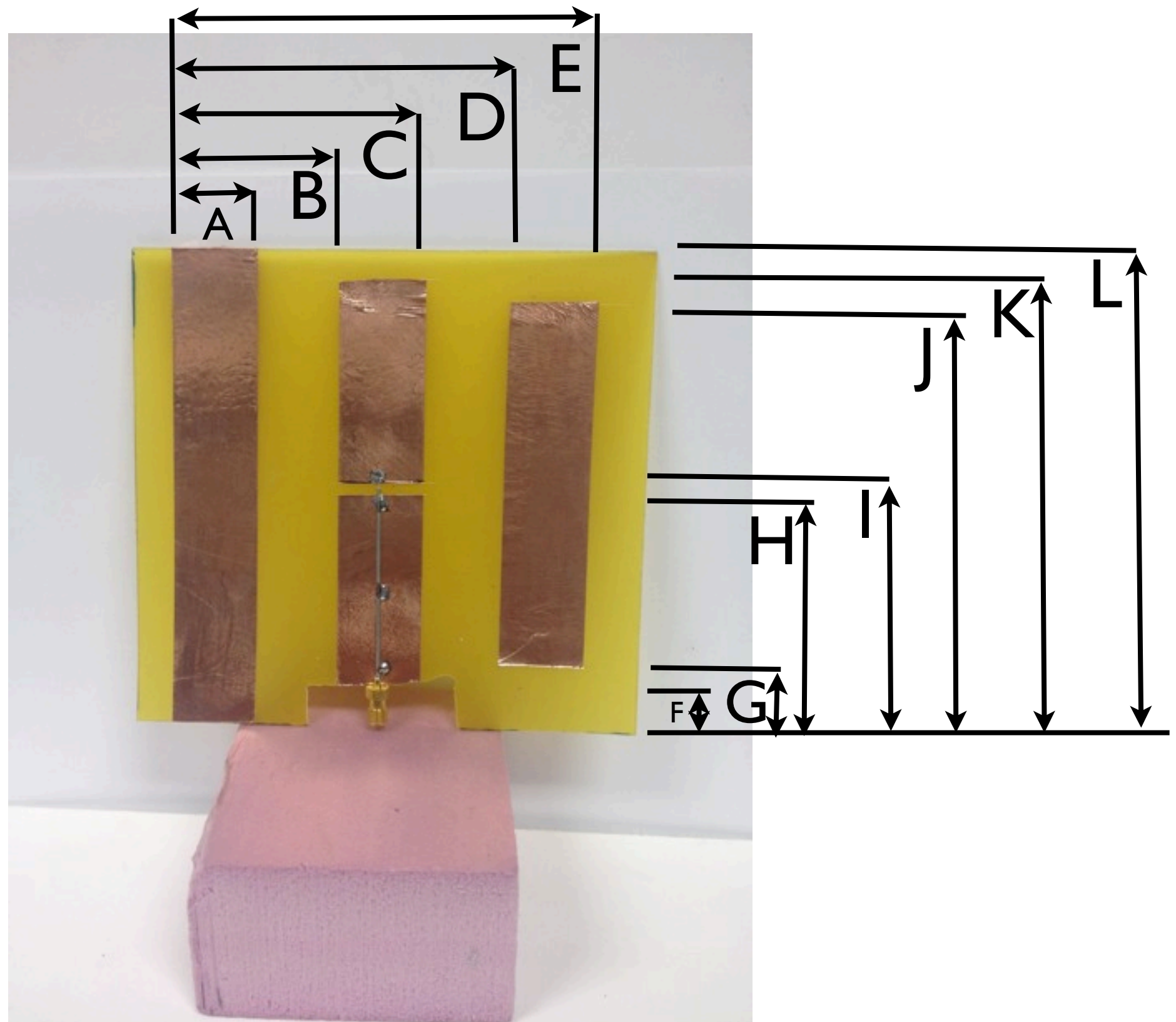
50 Ohm
semi-rigid
coax cable
with sma
connector



Copper
Tape

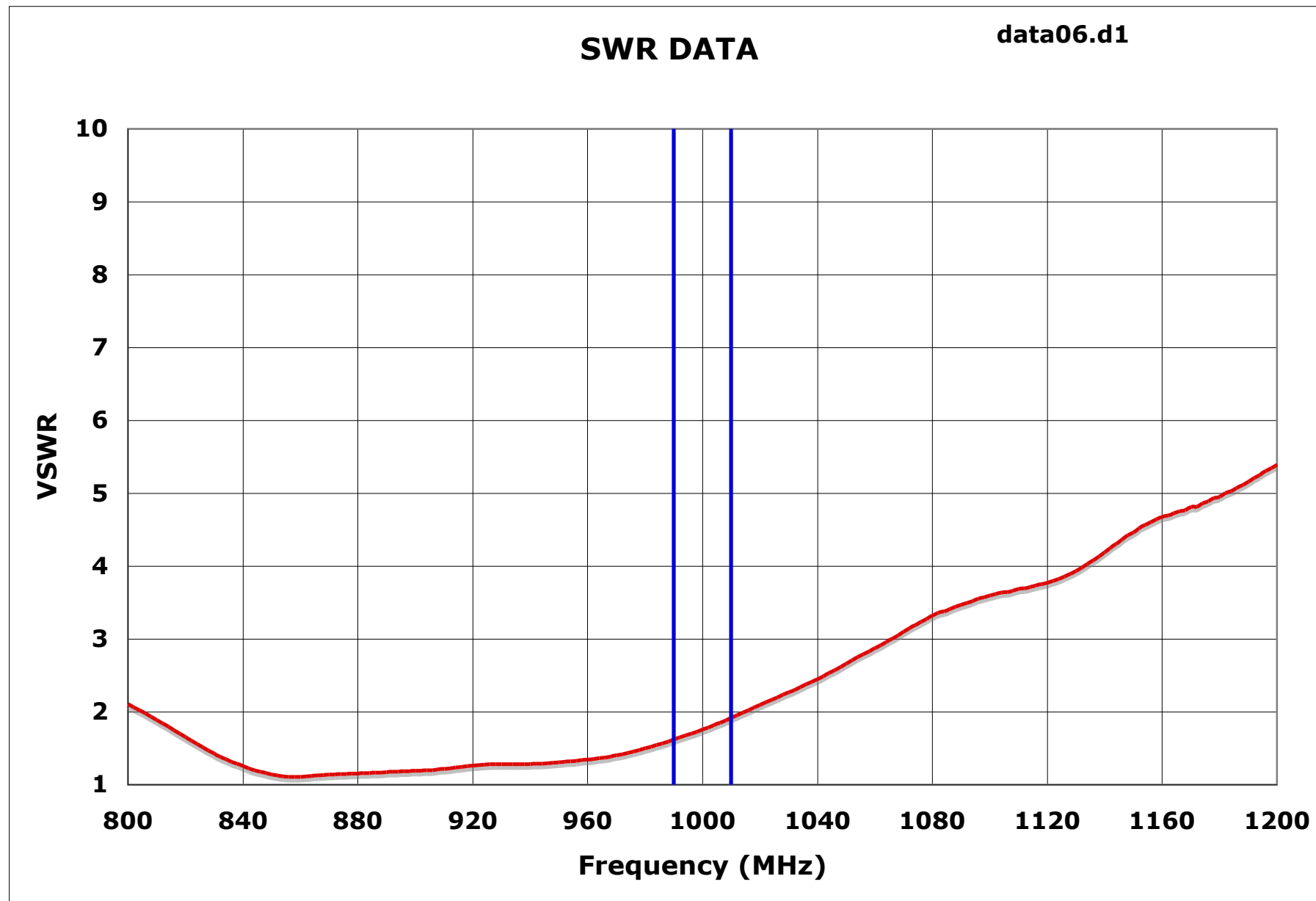
FR4
Support

Yagi Antenna

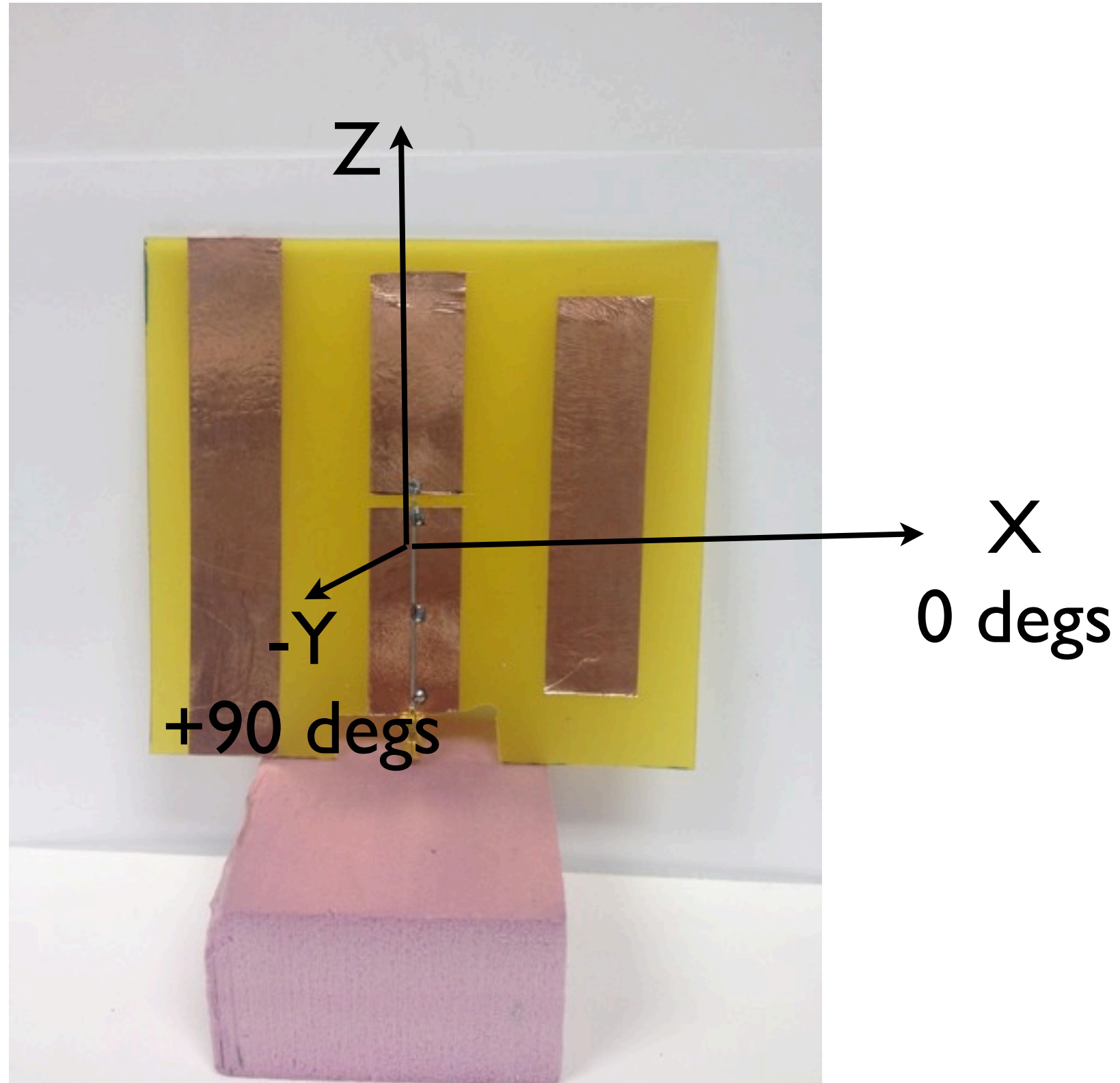


3 Element Yagi Antenna		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	1.00	0.083
B	2.00	0.167
C	3.00	0.250
D	4.00	0.333
E	5.00	0.417
F	0.50	0.042
G	0.80	0.067
H	2.80	0.233
I	3.00	0.250
J	5.00	0.417
K	5.30	0.442
L	5.70	0.475

Yagi Antenna: VSWR



Vertical Polarization Pattern Orientation

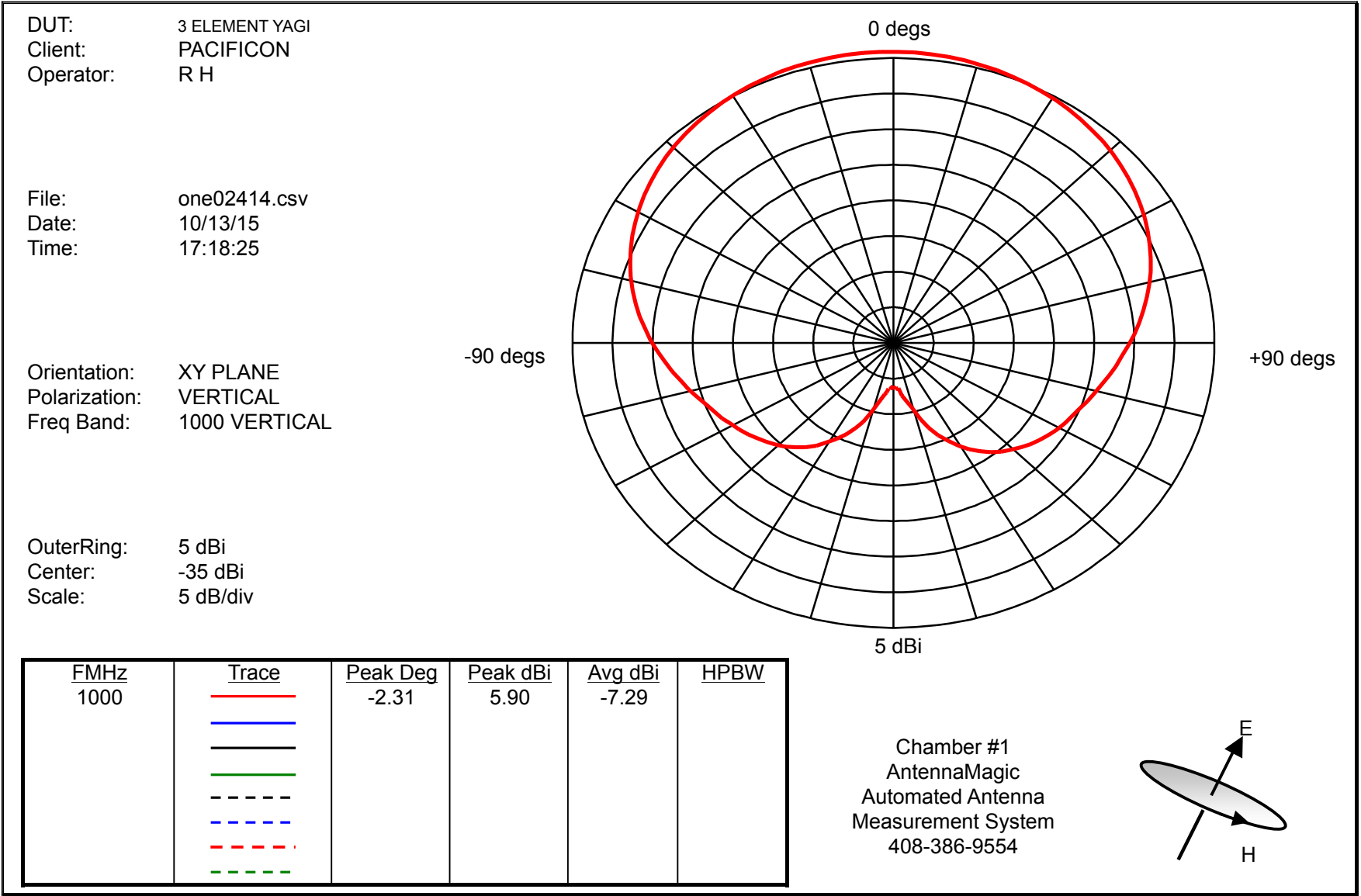


Yagi Antenna: Vertical Pattern

Antenna Radiation Pattern

MagicPlots.xls

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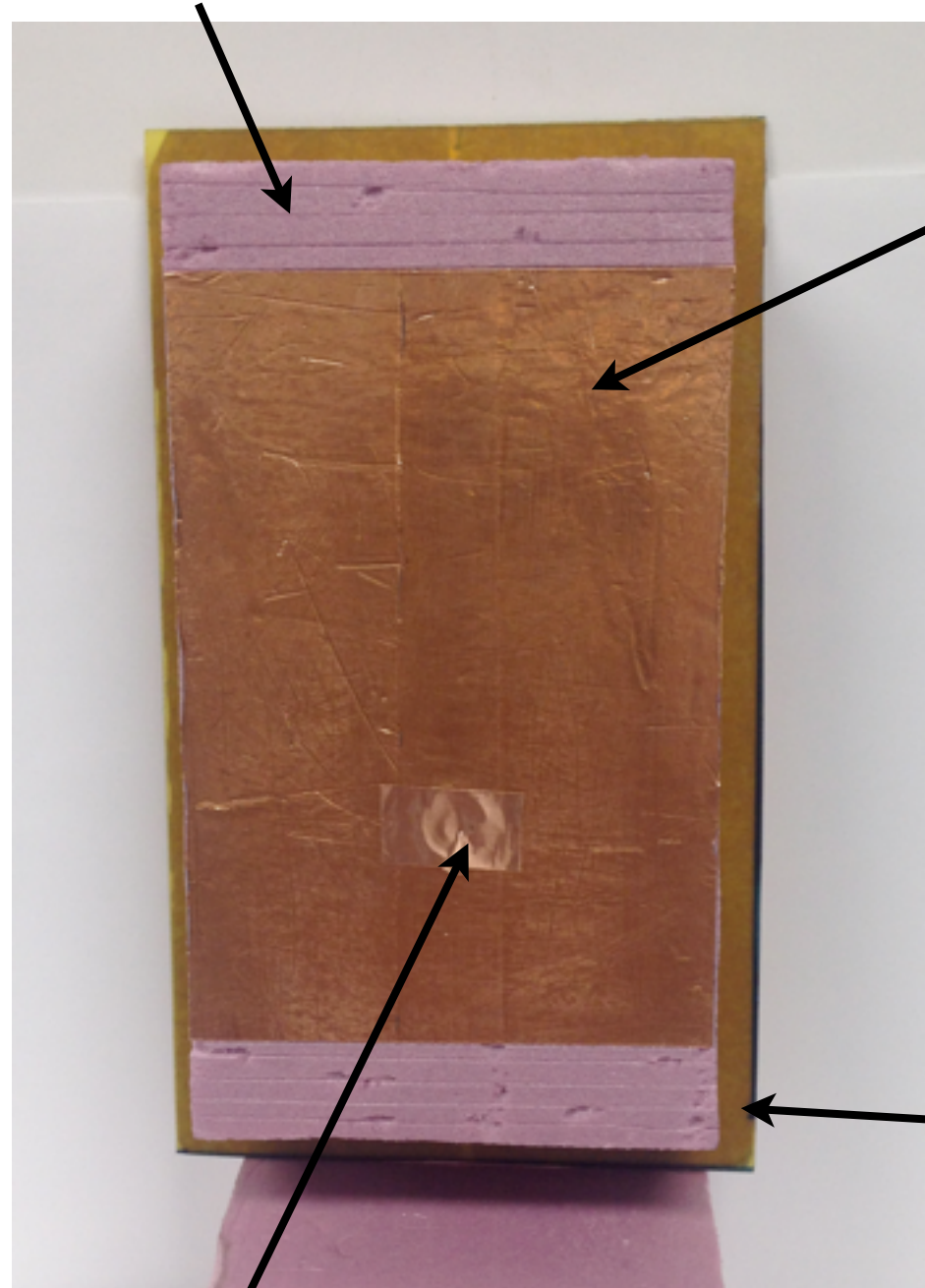
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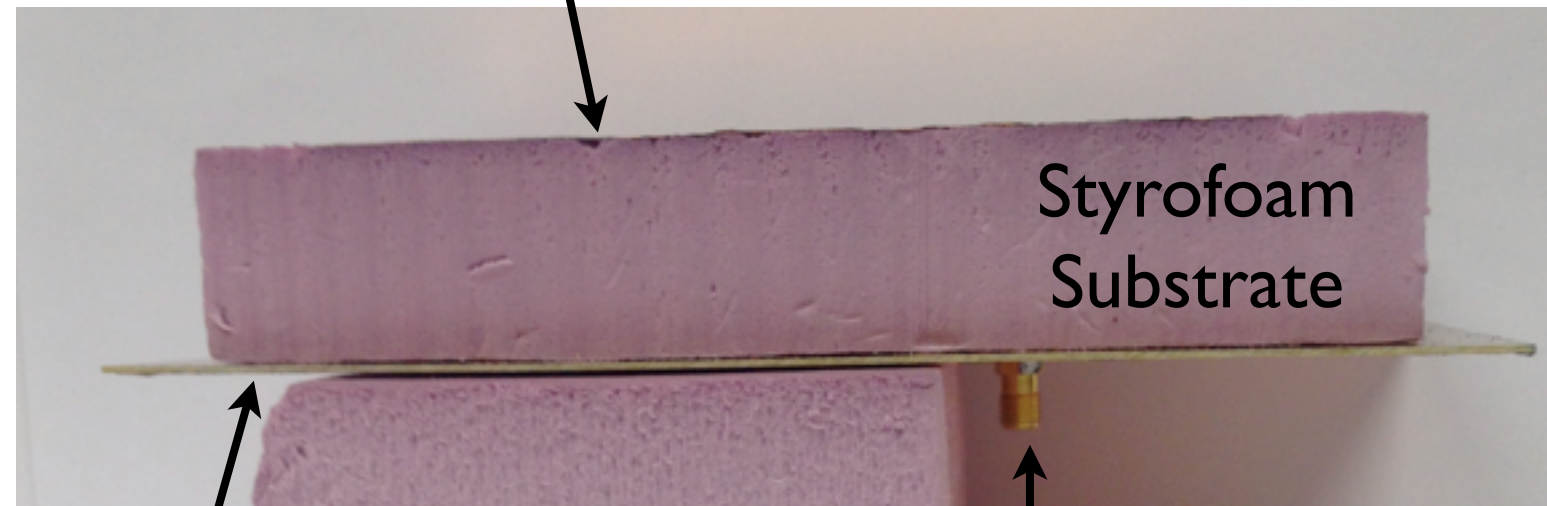
R Hill

Patch Antenna

Styrofoam
Substrate



Copper Tape on Top



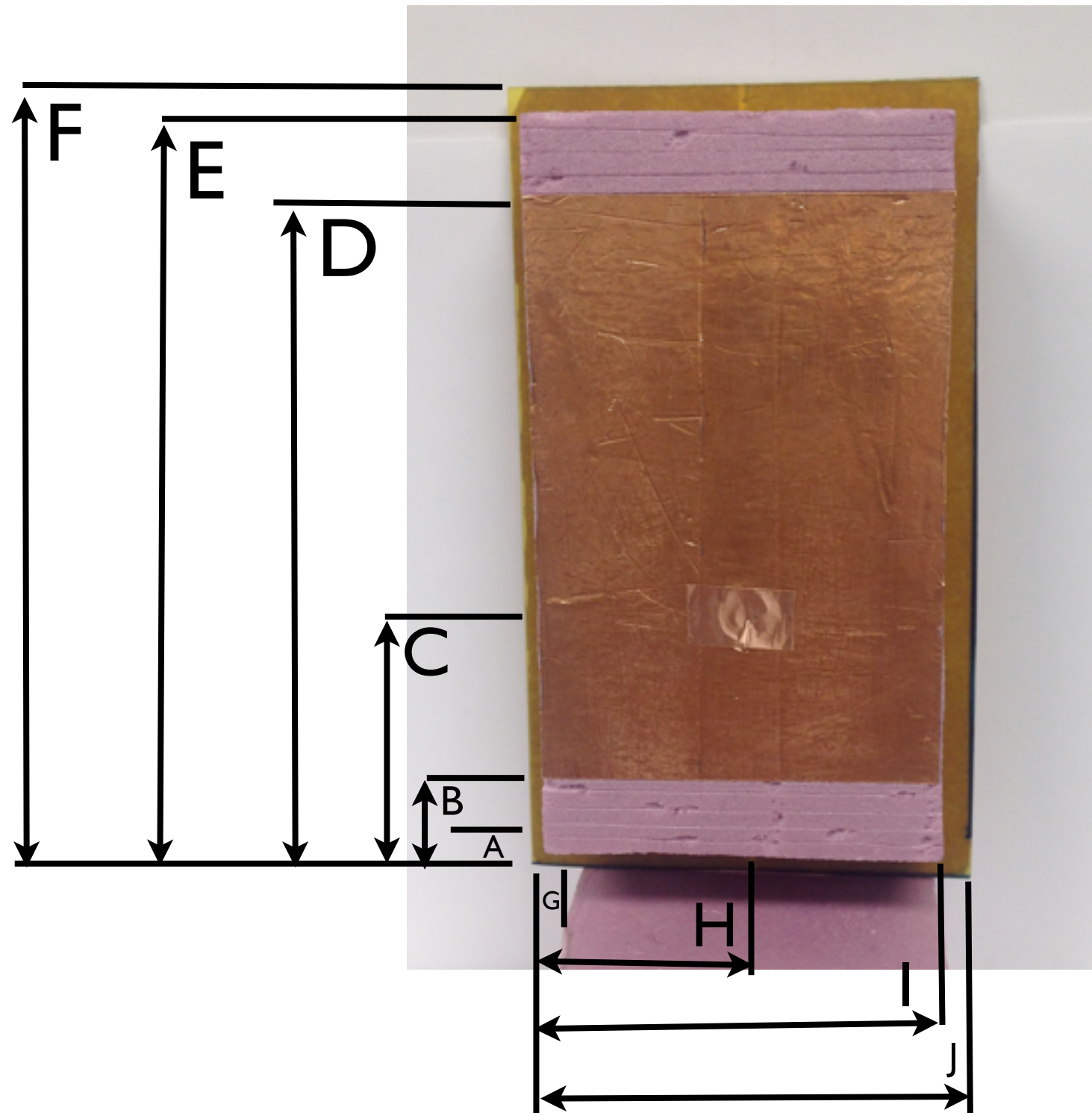
Styrofoam
Substrate

FR4 with
Copper Tape on
Bottom

50 Ohm
semi-rigid
coax cable
with sma
connector

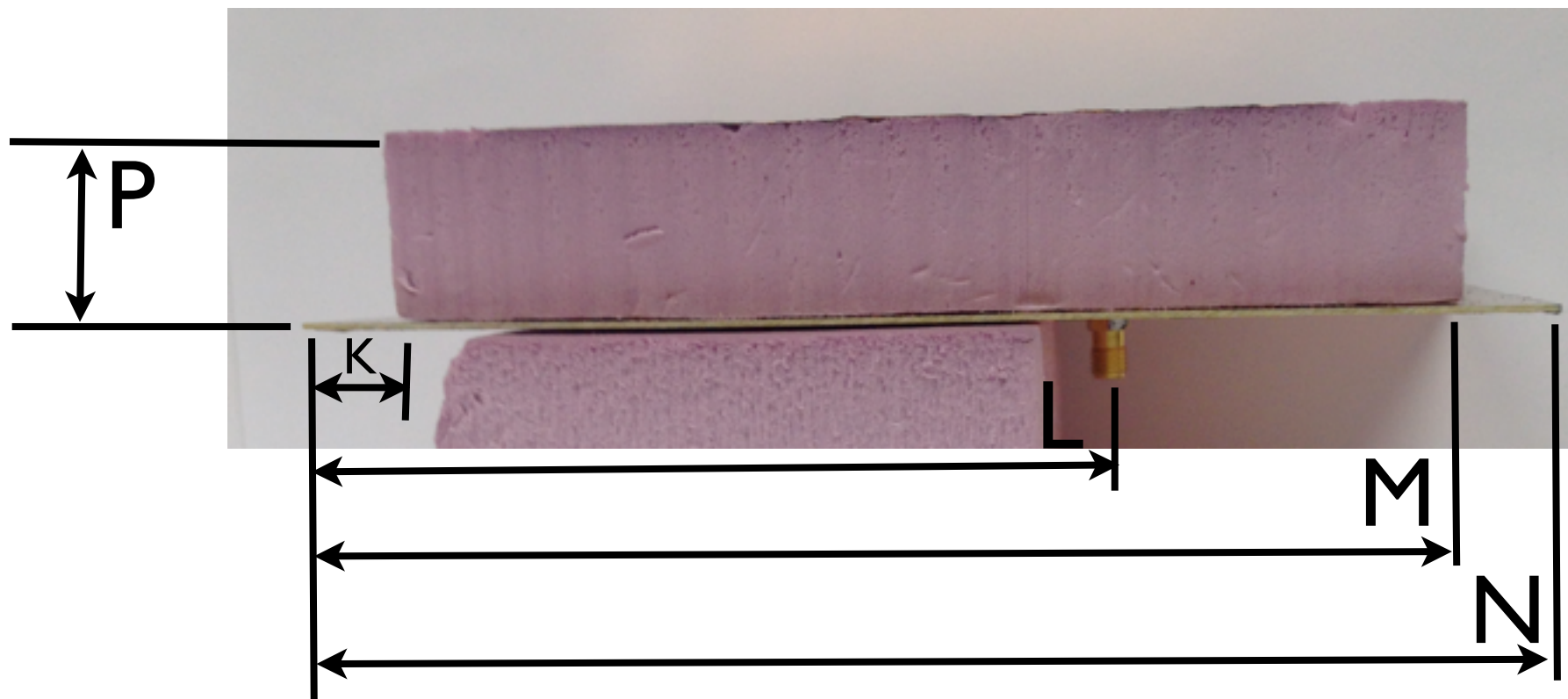
FeedPoint

Patch Antenna



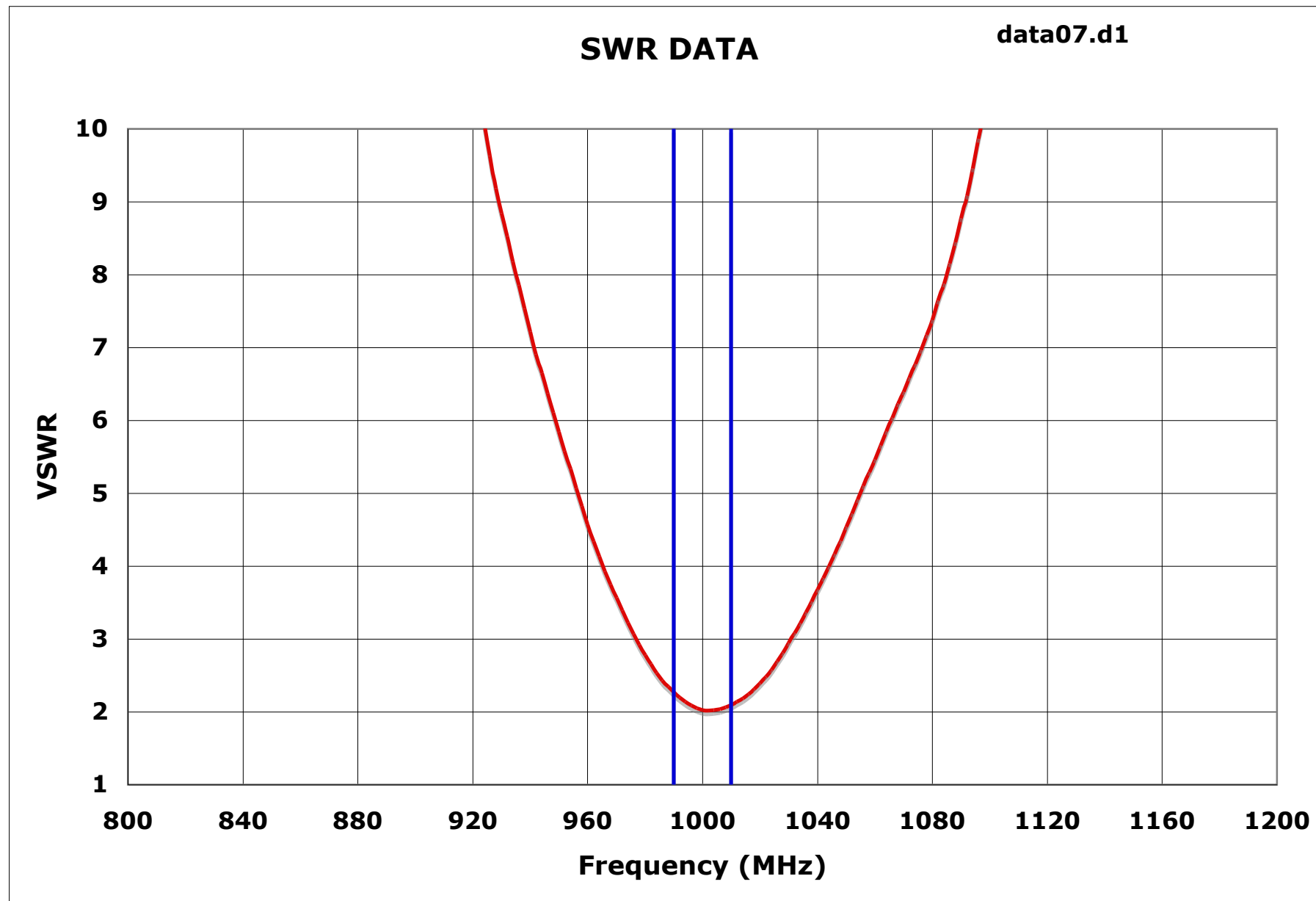
Patch Antenna		
Photo Dimension	Dimension in inches	Percentage of wavelength
A	0.40	0.033
B	1.10	0.092
C	2.40	0.200
D	5.80	0.483
E	6.40	0.533
F	6.80	0.567
G	0.40	0.033
H	2.00	0.167
I	3.60	0.300
J	4.00	0.333

Patch Antenna

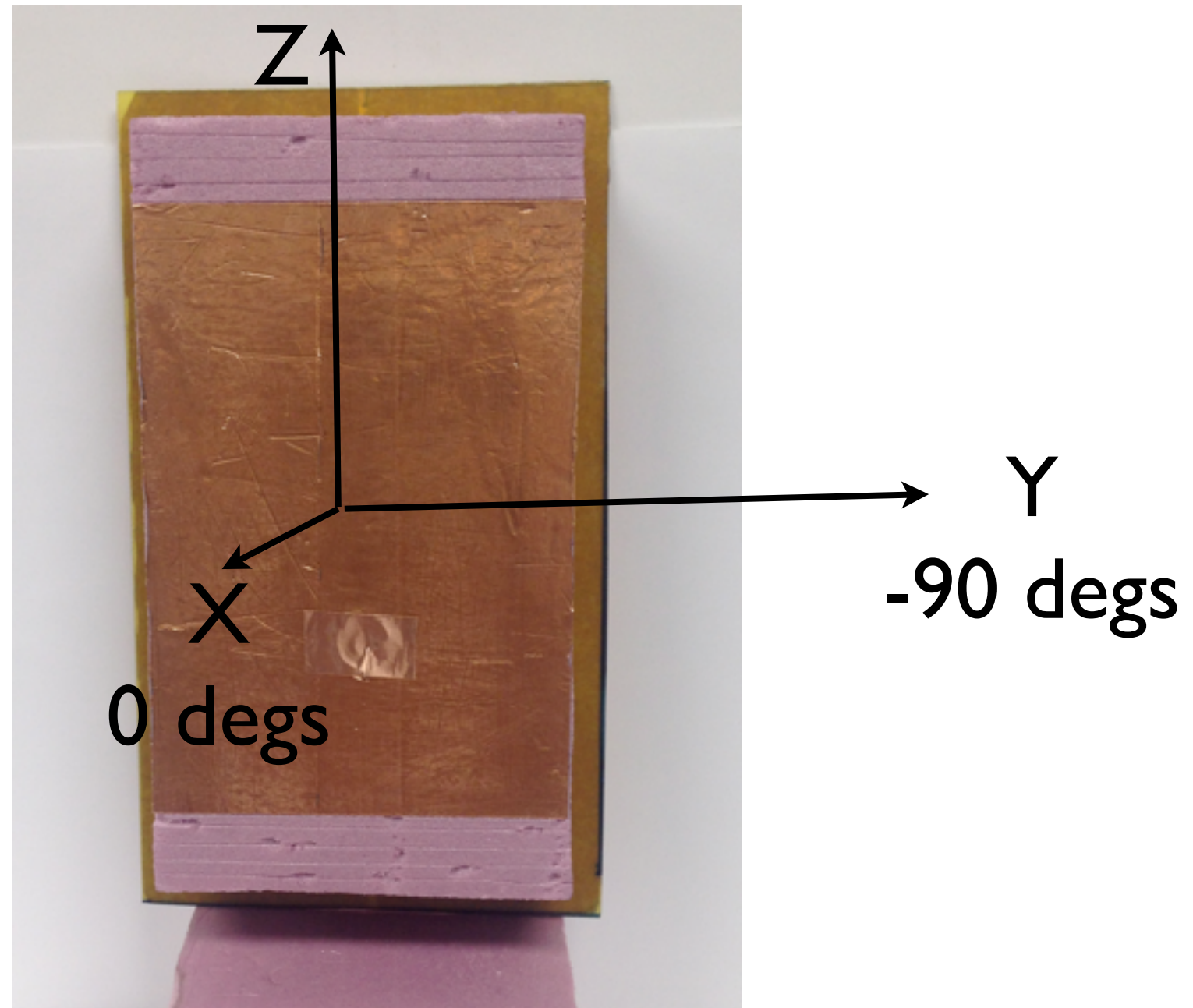


Patch Antenna Side View		
Photo Dimension	Dimension in inches	Percentage of wavelength
K	0.40	0.033
L	4.40	0.367
M	6.40	0.533
N	6.80	0.567
P	1.00	0.083

Patch Antenna: VSWR



Vertical Polarization Pattern Orientation

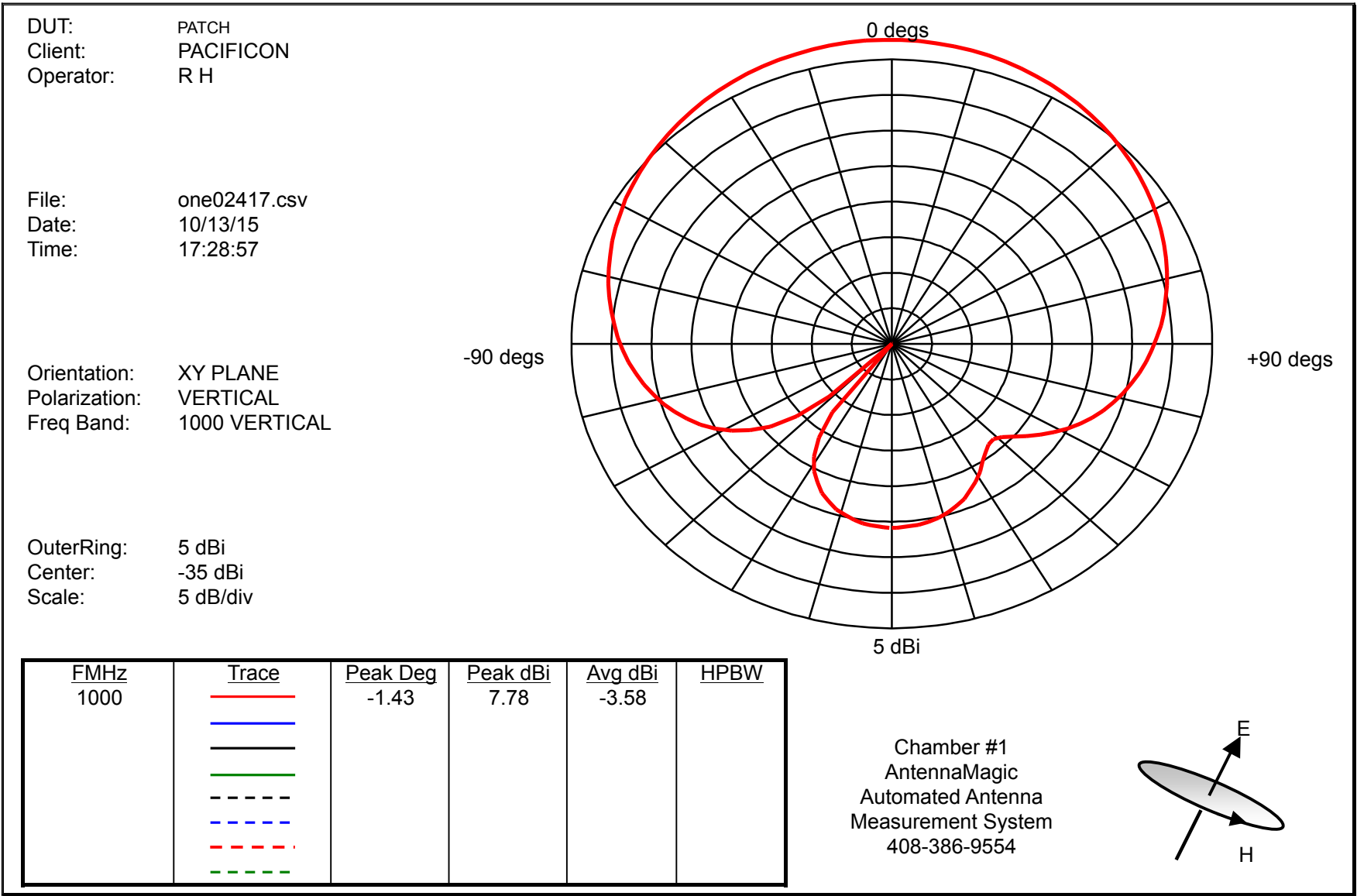


Patch Antenna: Vertical Pattern

Antenna Radiation Pattern

MagicPlots.xls

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DATA SUMMARY

ANTENNA	BANDWIDTH
IN-LINE DIPOLE	WIDE
PERPENDICULAR DIPOLE	GOOD
LOOP	GOOD
DOOP	GOOD
IFA	GOOD
YAGI	GOOD
PATCH	NARROW
SLOT	NARROW

ANTENNA	GAIN (dBi)
PATCH	7.0
YAGI	6.0
IFA	3.0
LOOP	2.5
SLOT	2.2
IN-LINE DIPOLE	2.0
PERPENDICULAR DIPOLE	2.0
DOOP	0.0

ANTENNA	PATTERN
PATCH	DIRECTIVE LINEAR
YAGI	DIRECTIVE LINEAR
LOOP	FIG 8 HPOL
PERPENDICULAR DIPOLE	FIG 8 HPOL
SLOT	FIG 8 VPOL
DOOP	OMNI HPOL
IFA	OMNI VPOL
LOOP	OMNI VPOL
IN-LINE DIPOLE	OMNI VPOL

Questions?

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